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TECHNICAL DATA

105/CA2735 AND 105/CA2736

DIGITAL MULTIMETER TYPE 7040 and ACCESSORIES Technical Manual

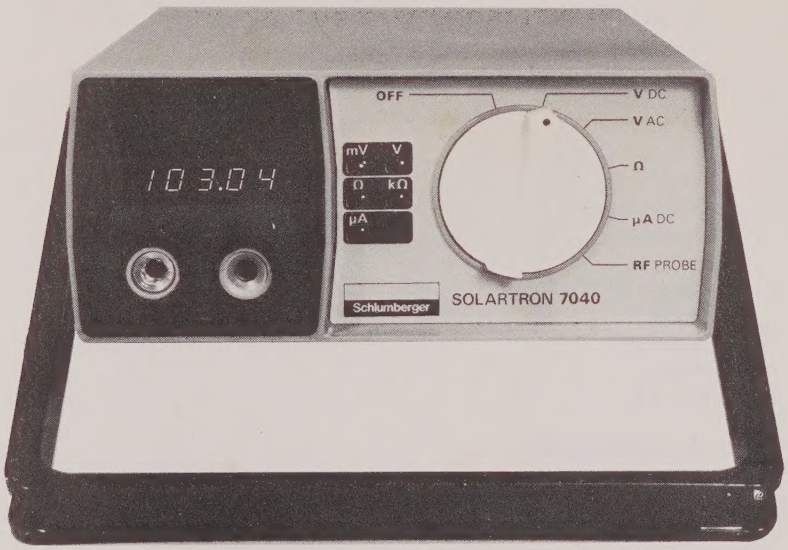
TTO Office

Part 1 Multimeter

Part 2 Accessories

Part 1

DIGITAL MULTIMETER 7040



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TECHNICAL MANUAL

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SECTION 1 General

The 7040 Digital Multimeter (DMM) combines the advantages of a compact and versatile multimeter with the precision and convenience of a digital instrument. Automatic ranging and polarity decision give rapid and accurate readings. The complete absence of range switching enables the user to concentrate on the task in hand and apart from selecting the actual measurement mode required, all other measurement decisions are undertaken automatically so reducing the risk of damage to the users equipment, as well as to the DMM.

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SECTION 2 Operating Instructions

This section provides all the necessary instructions concerning preliminary adjustments and operating procedures required to put the instrument into every-day use.

PRELIMINARY ADJUSTMENTS

Before using the instrument, the following preliminary adjustments should be carried out:

(a) Check the local mains supply voltage.

(b) Check that the voltage selection indicator (red pip) is fitted in the correct voltage range position. If necessary, remove the two rear thumb-screws and then carefully remove the back panel. Reposition the voltage selector as required.

(c) Check that the correct size of fuse is fitted as follows:-

100mA SLO-BLO

(d) Reposition the rear panel and then replace the two thumb-screws.

(e) Connect a suitable connector to the input mains lead as follows:-

Brown	-	Line (Live)
Blue	-	Neutral
Yellow/Green	-	Earth

(f) Switch the mode selector to OFF.

(g) Plug in the mains input lead firmly and then apply mains to the instrument.

(h) Select (VDC). The display should light up along with the (mV) indicator. The display reading may flicker initially but should settle down quickly to a steady reading of OV. The last digit of the display may flicker during the first hour of operation due to warm-up drift.
If required, a small offset (± 5 digits) can be applied for 'backing off' external offsets (e.g. thermal emf's from relay contacts) by adjusting with a long narrow bladed screwdriver, the zero set control located behind the left hand handle tilt adjustment.

(j) Where possible, the following calibration should be carried out in order to achieve the maximum accuracy for which this DMM is capable.

i. Switch on and allow the DMM to warm-up for at least 1 hour.

ii. Apply a known positive voltage of approximately 10V and check that the display indicates a positive input (-ve not indicated).

iii. If necessary, correct reading by adjusting CAL + (located bottom right-hand of rear panel).

iv. Reverse input leads, and adjust CAL - for the same reading.

(k) This completes all the preliminary adjustments required for normal use.

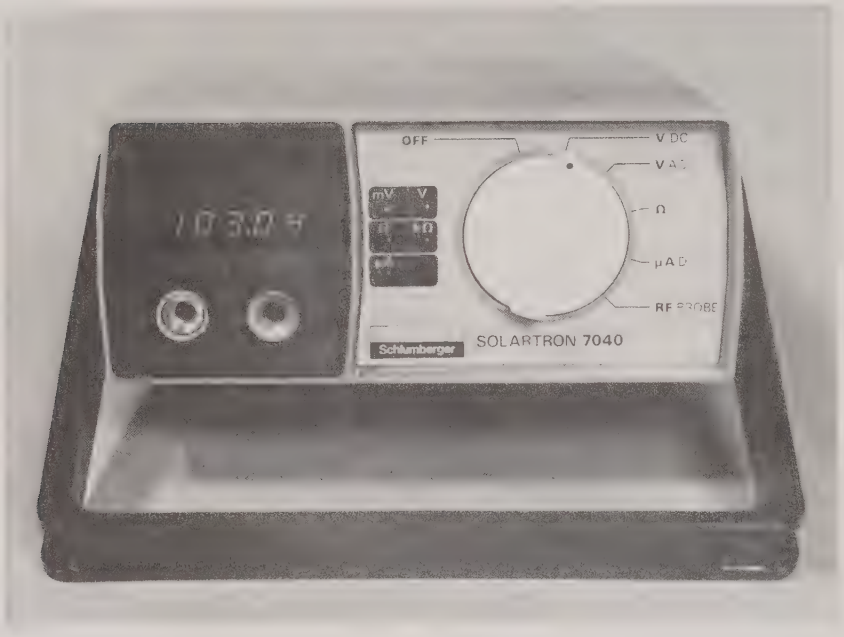


Figure 2 - General View of DMM Model 7040

WARNING

This instrument has built-in fuse protection to prevent damage to the input amplifier when used in the DC CURRENT mode. If the display remains at OV despite the application of known dc currents, the input fuse will almost certainly be blown. The fuse may be changed as follows:-

i. Unscrew one of the rear thumb-screws from the case.

ii. Remove the input lead assembly.

iii. Using the thumb-screw as a wrench, unscrew the + input socket until the whole assembly is released.

iv. Replace or check the fuse. Replacement fuses must be exactly as supplied - 50mA SLO-BLO.

v. Replace the components in the following order: (a) fuse, (b) spring, (c) fuse holder.

OPERATION

The operation of this instrument under most conditions will be found to be self-evident. The only operator decision required is the selection of the measurement mode required.

During operation, the following factors should be borne in mind:-

i. Since the instrument will automatically change ranges to suit the applied input potential, care should be taken to note the decimal point position in combination with the unit indicators.

ii. When the AC mode is selected, allow up to 3 seconds for the DMM to settle down when the applied potential differs wildly from the previous reading.

iii. In the event of an unintentional overload, causing the display to flash, the offending potential should be removed since continuous overload will eventually cause damage to the input amplifier circuitry. Evidence of amplifier damage will usually cause the display to show some large value of input even when the input leads have been removed.

iv. Due to the high input impedance of the input amplifier, the display reading will drift about when the instrument is left open-circuit, i.e. no input condition, due to interference pick-up. This will sometimes cause the range relay to 'click' in and out at a slow rate. This condition is normal but if the 'clicking' proves annoying, it can be prevented by shorting the input leads together between readings.

Provided the above precautions are observed, the DMM will prove to be virtually indestructable under all normal measurement applications.

SECTION 3 Servicing

This section provides detailed servicing information for the instrument. Setting-up procedures and calibration are covered in SECTIONS 4 and 5 respectively.

INTRODUCTION

This Servicing Section is based on the functional block system of circuit diagrams, whereby components are grouped together to form a functional entity. A large scale block diagram is used to describe the overall operation of the Digital Multimeter (DMM). This diagram is then sub-divided to produce blocked circuit diagrams.

Information regarding circuit descriptions, component locations, printed circuit board layouts and any specific cautionary notes concerning components or testing procedures are located adjacent to the appropriate circuit diagram. Full calibration and setting-up procedures are located at the rear of this manual.

PRESENTATION OF INFORMATION

A brief glance through this section will reveal that the section is divided up into several major sections, each section dealing with a major function within the DMM. Located within each section are block type diagrams, always folding out clear to the right, with a functional description of each block located on a left-hand text page.

Referring to any of these diagrams, it can be seen that the major functional signal pathways are shown as bold lines, whilst those of a minor or control function are shown with thinner lines. The arrows indicate the direction of functional flow, which in the majority of cases will be from left to right of the diagram. Most feedback paths however, will flow from right to left.

These rules, although generally followed, are not rigidly adhered to where observance may cause ambiguity or is extravagant of space.

Component Location

Diagrams of the printed circuit boards associated with each circuit diagram and photographs illustrating the method of access are reproduced in a manner enabling them to be examined in conjunction with the diagrams. By this method the physical position of any component can be quickly established.

Component Numbering

It should be noted that the method of component numbering is based on the components of a printed circuit board. This means that on a circuit diagram more than one component may be shown with the same component number. When this occurs care must be taken to ensure that the correct part is identified if it is required to replace the component. For instance, in the 7040 there are several p.c.b.'s, three of which include a component numbered R1. If it is required to replace one of these, the correct item must be identified from the parts list by reference to the p.c.b. or assembly on which it is mounted.

Test Points

Located on the circuit diagrams are test point symbols each annotated with a TP number. Examination of the corresponding p.c.b. track shows that each of these points corresponds to a large pad with the appropriate TP number. These pads are used at the factory in conjunction with automatic test equipment. Since these pads identify specific points on each circuit diagram, they may be used as convenient check points to identify the section of circuitry which may be operating incorrectly. Care should be taken not to short these pads to the adjacent p.c.b. linework.

Power Rail Notation

The method of depicting power rails in the circuit diagrams is a departure from normal practice. The rails are not shown as continuous lines but as short detached bars with the nominal voltage annotated. On any one p.c.b., all bars annotated with the same voltage are electrically connected together and correspond to the appropriate rail notation shown on the power supplies circuit diagram referenced 8. This system has been applied to all voltage rails with the exception of the OV rail which, due to its close association with the signal paths, has been separately depicted on the analogue input circuit diagram referenced 1. Where necessary a rail reference letter is used to identify the decoupling components used for that group of components. It must be remembered that the voltages shown

are approximate, being proportional to the load taken through the appropriate decoupling resistors. A voltage reading that is inconsistent with the value given on the diagram should not, therefore, be taken as a symptom of unserviceability without reference to other indications.

FUNCTIONAL DESCRIPTION

The Model 7040 Digital Multimeter (DMM) may be looked upon as an instrument which divides down into three major functional areas. These are shown as coloured areas in the following fold-out KEY DIAGRAM.

This diagram should be looked upon as a pictorial index as within each of these coloured areas are further blocks, each referenced with a number which refers to a specific block/circuit diagram within each section of this manual.

It is important when using these diagrams that the information should be looked at from a functional view-point before dealing with any actual detailed servicing. That is to say, deduce what could be the problem before actually looking at specific circuit details.

With reference to the KEY DIAGRAM, the input signal is applied to an ANALOGUE signal processing section. The primary function of this block is to scale the input signal into a form suitable for use by the DIGITAL (A/D Converter) section.

The input signal in all cases is converted into a dc signal. Since the A/D Converter can only handle signals within the range 0-11V directly, the analogue section provides a 100/1 attenuation on the higher ranges.

The scaled analogue input is then converted into a digital form by means of the triple ramp technique of integration (for a detailed explanation, refer to Section 3B), the result of which is displayed on a light emitting diode (L. E. D.) display.

The third major functional block provides the power supplies to operate the whole instrument. This block also provides timing pulses to relate the measurement to the incoming mains supply frequency in order to provide some rejection to ac interference.

GENERAL NOTE:-

The numbers in each of the blocks shown below refer to the appropriate block and circuit diagrams contained in this section.

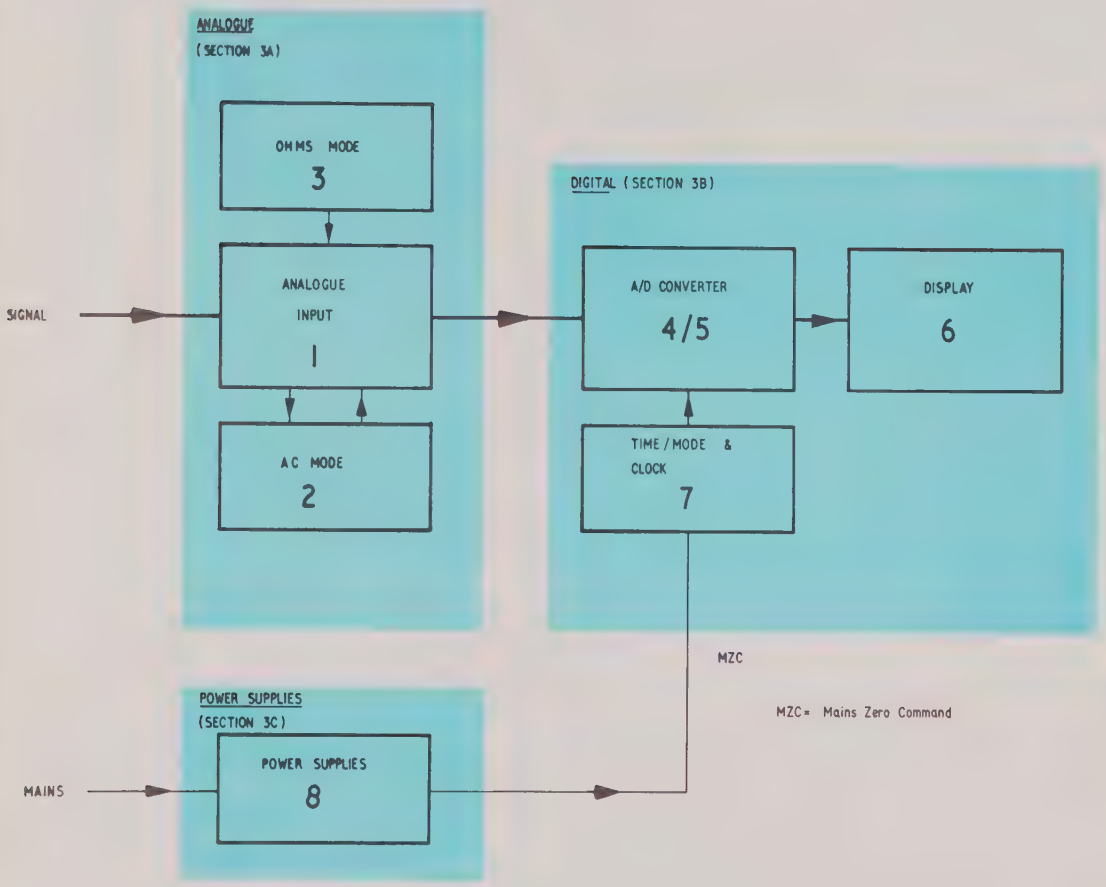


Figure 3-1 KEY DIAGRAM (Pictorial Index)

SUB-SECTION 3a Analogue

This sub-section deals with the ANALOGUE section of the instrument whose primary function is to convert the input signal into an acceptable form suitable for digital conversion by the DIGITAL section (SUB-SECTION 3B - DIGITAL).

SIGNAL CONVERSION

Introduction

The purpose of these sections of circuitry is to convert the incoming signal into dc suitable for conversion by the A/D Converter in the DIGITAL section of the instrument.

DC Measurement

In this mode of operation, since the applied signal is already dc, the circuitry serves to scale the input to within the upper 11V limit acceptable to the A/D Converter input.

The COMMON AMPLIFIER is arranged in a series feedback configuration to provide a very high input impedance to the applied signal on the unattenuated ranges (0-11V).

AC Measurement

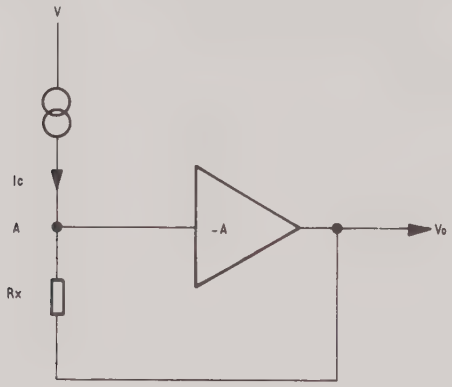
The section of circuitry used for converting the applied input to dc is shown separately on DIAGRAM 2.

The applied signal passes through a separate INPUT ATTENUATOR network and via a voltage follower (INPUT AMPLIFIER) is applied to a SUMMING JUNCTION. This point acts as a 'virtual earth' to the COMMON AMPLIFIER, the balancing inputs coming through the MEAN SENSING NETWORK. The mean sensing feedback path divides the output of the amplifier into positive and negative half-wave cycles by rectifier action. The positive half cycle output is filtered by the AC ACTIVE FILTER to form the equivalent dc input to the A/D Converter.

Since the rectified output would produce the mean value of the applied input, provision is made (RV2/BD3) to scale the signal input such that the final displayed reading is the rms (root mean square) as opposed to mean value of the applied signal. It should be remembered that this scaling action will only be valid when the input wave form is sinusoidal.

Resistance Measurement

This section of circuitry is shown separately on DIAGRAM 3. Consider the following simplified diagram :-



Point A is a 'virtual earth' input to a very high gain amplifier (COMMON AMPLIFIER). In order that the current flowing into and out of point A is balanced, the output of the amplifier Vo must rise to develop a potential drop across the applied unknown resistance Rx such that the constant current Ic derived from the reference voltage all flows through Rx. The final value of Vo when the circuit balances will be proportional to Rx and it is this output which is used by the A/D Converter for conversion to units of resistance.

Current Measurement

Following from the above description of resistance measurement, it can be seen that if we make Rx a known value (RV3/R5 on DIAGRAM 1), the output of the amplifier Vo will be proportional to the unknown applied current.

RF Probe Measurement

This mode is a fixed range current measurement used in conjunction with optional accessory units, reference should be made to appropriate sections of this manual for further details.

SPECIAL INSTRUCTIONS

Unprotected M.O.S.T.'s TR1/2 (P.C.B. No.1)

Whenever installing or removing these components, it is essential that the wire leads are always shorted together with wire (e.g. fine fuse wire) to protect the device from static breakdown when handled.

Reference Zener Diode D13 (P.C.B. No.1)

Whenever zener diode D13 is replaced, the following set-up procedure should be adopted.

(a) Using a desoldering tool, carefully remove any existing solder bridging solder pads 'A' and 'B' (refer to Figure 3A-7 for location).

(b) Adjust RV5 (Bd 1) to approximately mid-range.

(c) Using a DVM, monitor TP8.

i. If reading < 9.95V, short circuit R37 by bridging pad 'B'.
If reading > 9.95V, solder pad 'B' and go to step (d) below.

ii. If reading still < 9.95V, remove short circuit from pad 'B' and then short circuit R36 by bridging pad 'A'.
If reading > 9.95V, solder pad 'A' and go to step (d) below.

iii. If reading still < 9.95V, short circuit both R36 and R37 by bridging pads 'A' and 'B' together.
If reading > 9.95V, solder pads 'A' and 'B' and go to step (d) below.
If reading still < 9.95V, replace D13 and start again at step (a) above.

(d) When TP8 reads > 9.95V, adjust RV5 (Bd 1) for a reading of 10.000V.

(e) Remove test equipment.

TEST WAVEFORMS

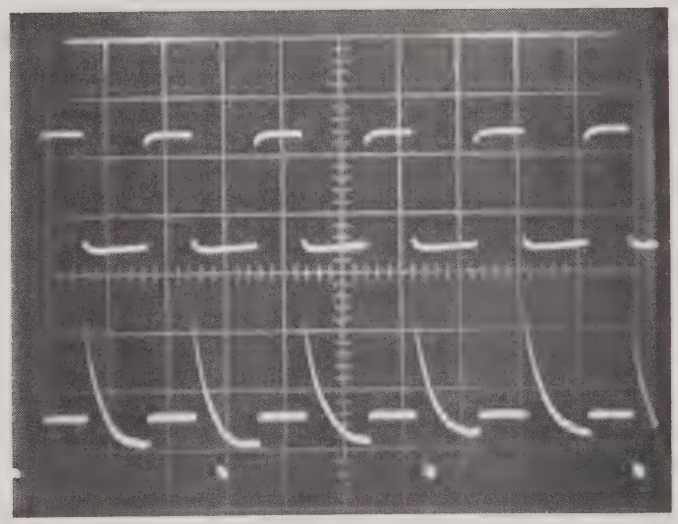
Frame 3A-1

Upper Trace

A typical output waveform produced by the CHOPPER DRIVE (DIAGRAM 1A) at TP16. The output at TP13 is an inverted form of this trace.

Lower Trace

A typical output waveform produced by the DEMODULATOR (DIAGRAM 1A) at TP15.



Frame 3A-1 CHOPPER/DEMODULATOR Waveforms

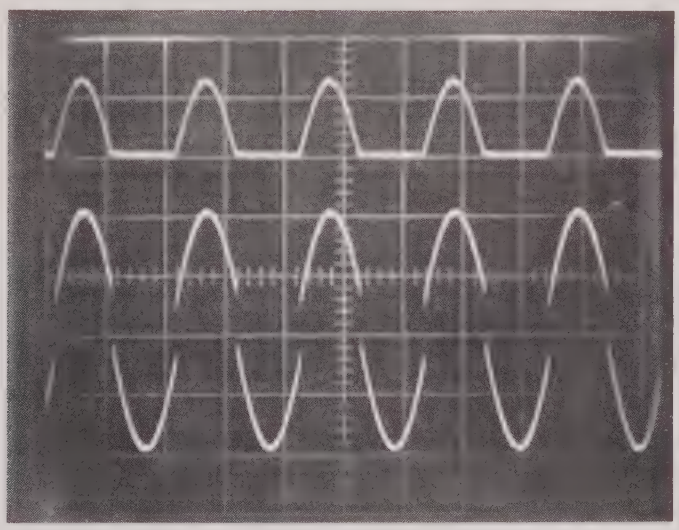
Frame 3A-2

Upper Trace

A typical output waveform produced at TP6, the output from block MEAN SENSING FEEDBACK NETWORK (DIAGRAM 2) used to provide dc to the A/D Converter.

Lower Trace

A typical output provided by the complementary common base stage formed by TR1/2 in block MEAN SENSING FEEDBACK NETWORK (DIAGRAM 2) used to drive both halves of the diode feedback loop. The sharp transistions about zero of the output waveform overcome possible non-linear rectification due to diode characteristics up to about 0.7V.



Frame 3A-2 MEAN SENSING FEEDBACK Waveforms

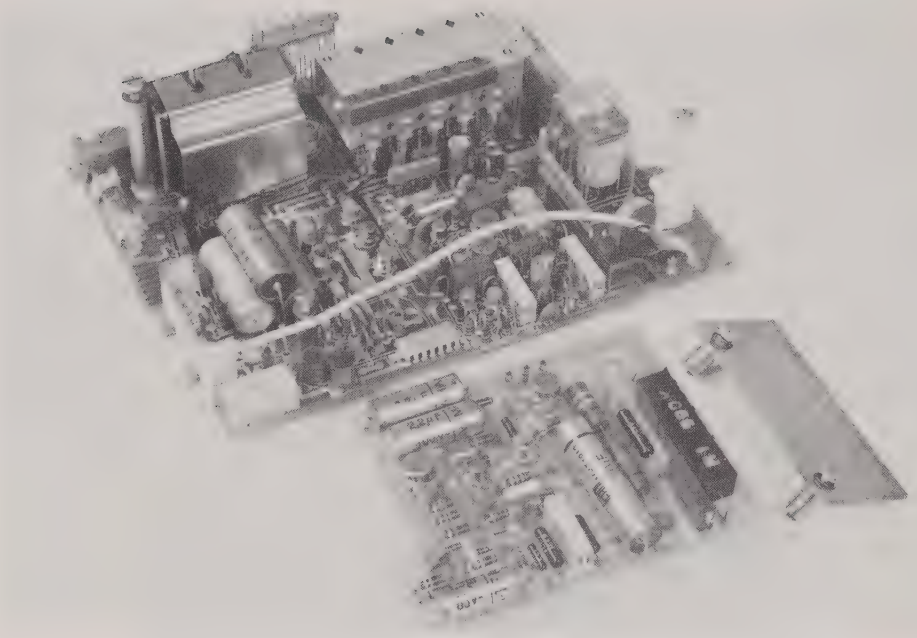


Figure 3A-1 Access to ANALOGUE Section

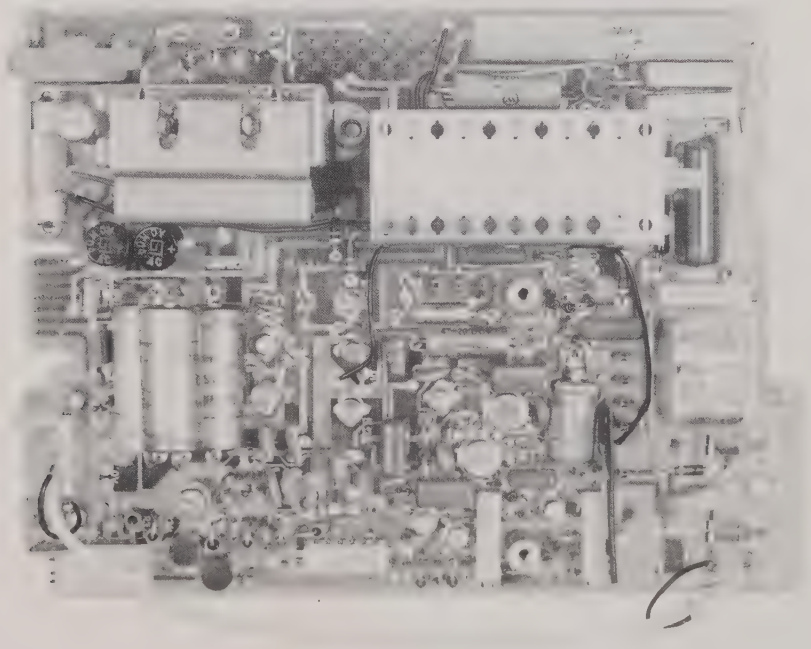


Figure 3A-2 (P. C. B. No. 1) General View (TOP)

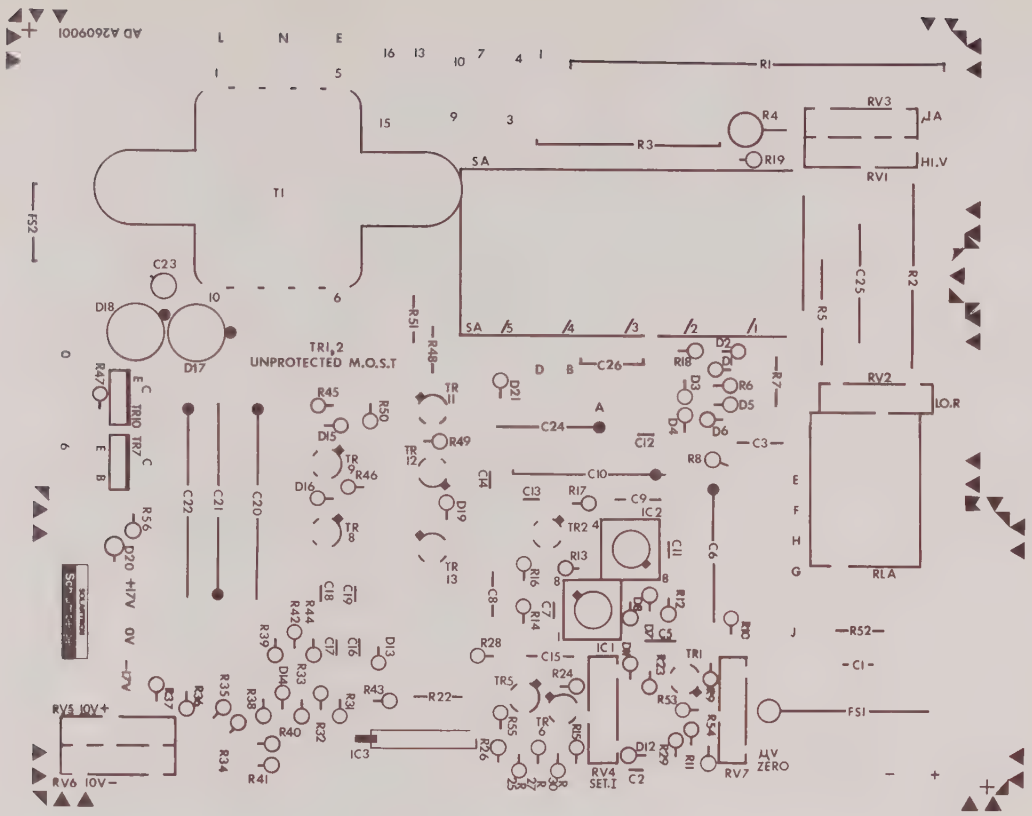


Figure 3A-3 (P.C.B. No. 1) Component Notation

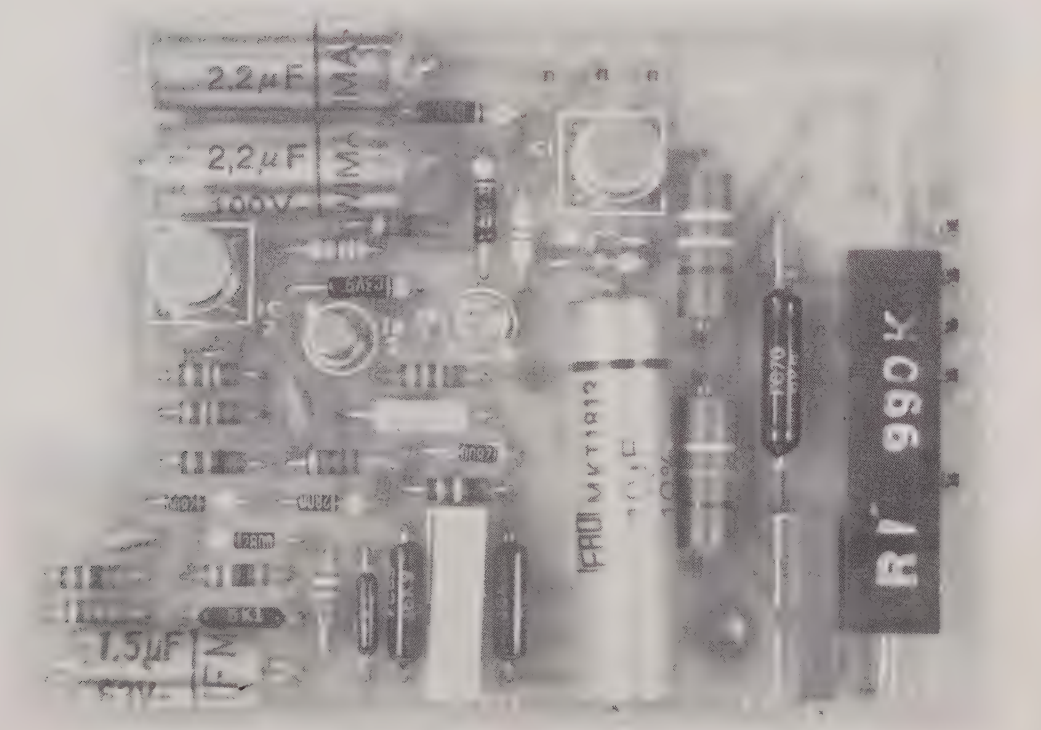


Figure 3A-4 (P.C.B. No. 3) General View (Top)

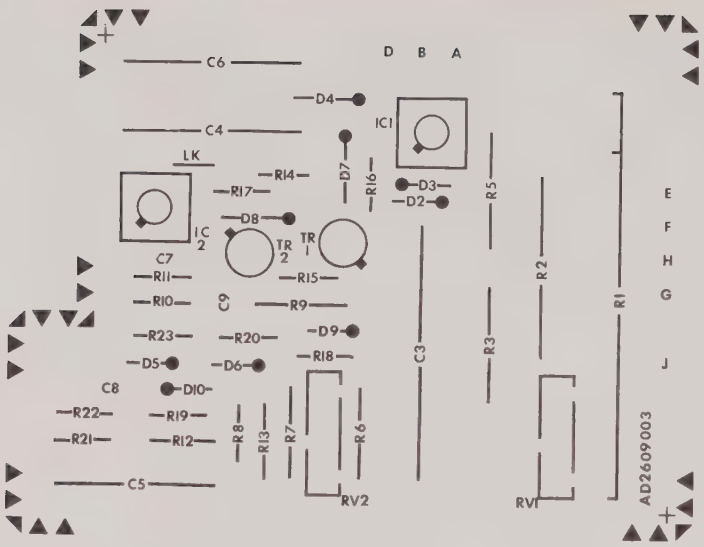


Figure 3A-5 (P.C.B. No. 3) Component Notation

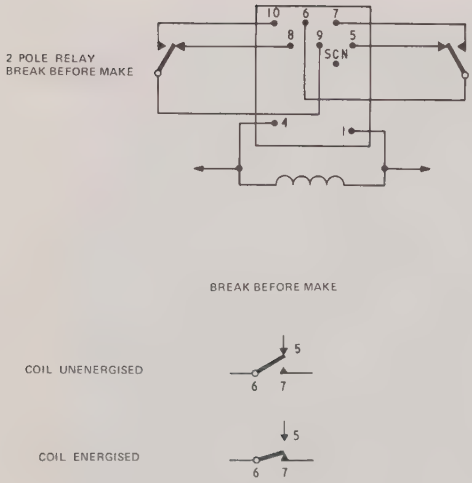


Figure 3A-6 Relay RLA

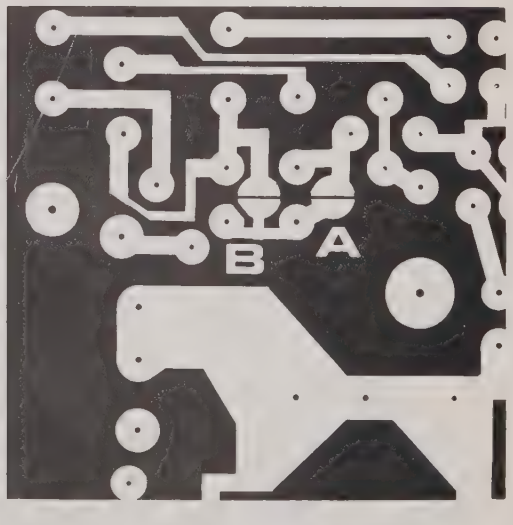
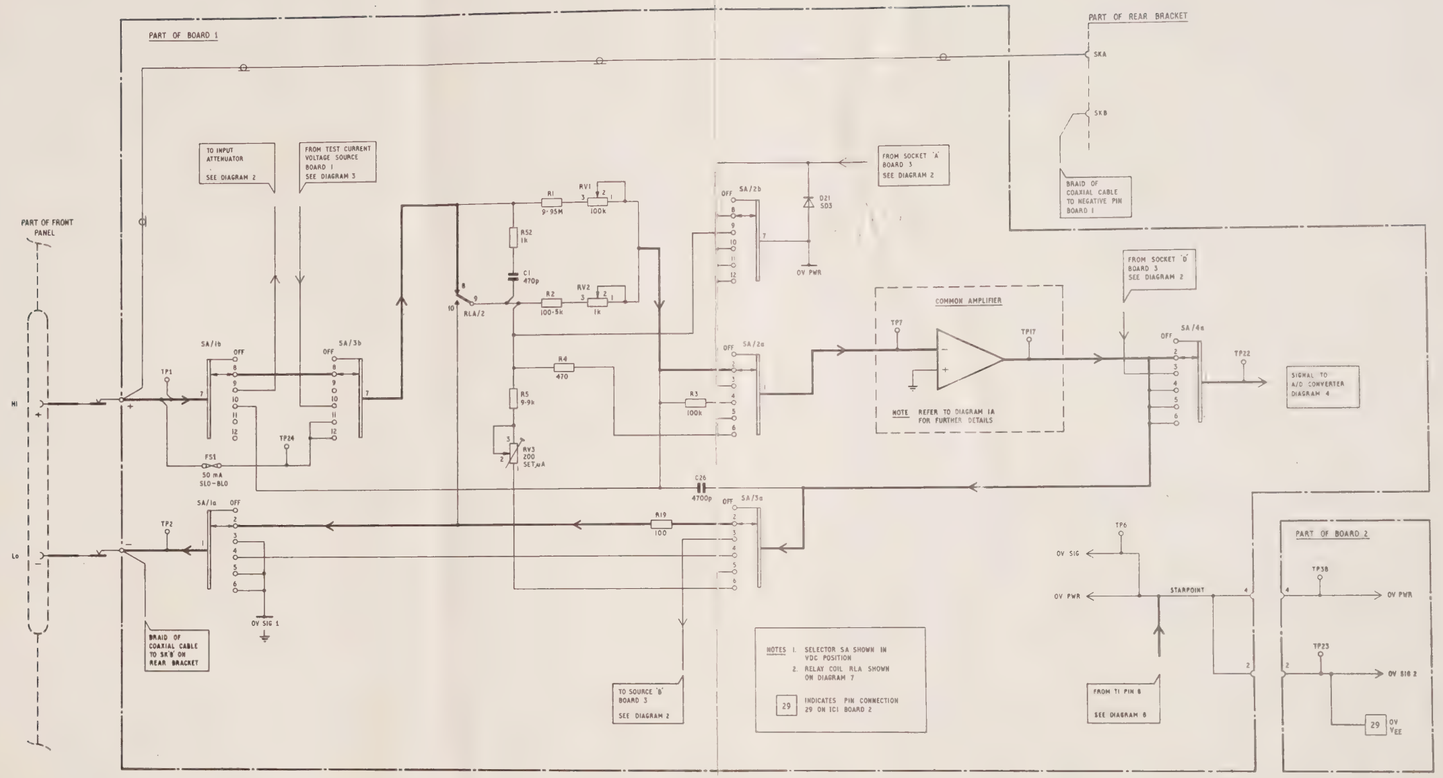


Figure 3A-7 D13 Solder Pads



1

ANALOGUE SECTION (OVERALL CIRCUIT DIAGRAM)

PROTECTION NETWORK

D1 and D2 protect the CHOPPER AMPLIFIER during overload conditions. D3/D4 in conjunction with D5/D6 limits the OUTPUT AMPLIFIER output to within ±12V.

LOW-PASS FILTER

R8, R9 and C3 form a low-pass filter which removes the high frequency components (>100Hz) from the dc channel and prevents spikes from the CHOPPER (Modulator) circuitry reaching the input terminals.

CHOPPER DRIVE

A 400Hz emitter-coupled Multivibrator TR5/6 for driving the CHOPPER and DEMODULATOR.

A small proportion of the anti-phase output is applied via RV4 to minimise chopper spikes produced by TR1 in the CHOPPER (Modulator) circuitry.

(Refer to Section 4 - Setting Up Procedure for details on the adjustment of RV4).

CHOPPER (MODULATOR)

The filtered output from the LOW PASS FILTER is 'chopped up' by alternately shorting the signal to earth via TR1 to form an ac type signal. The chopping action is controlled by the in-phase output of the CHOPPER DRIVE multivibrator.

Anti-phase chopper drive is applied to G2 of TR1 to minimise chopper spikes.

RV7 (μv ZERO) provides a small dc offset to the chopper output to compensate for the small offsets or to provide a small offset (±5 bits) to the display to allow for external offsets due to thermal emf's etc.

CHOPPER AMPLIFIER

IC1, whose gain and frequency response are defined by C6, C7, R12 and R13, amplifies the input (chopped) wave-form produced by the CHOPPER (Modulator) to produce an output consisting of a voltage proportional to its input plus its own internal dc offset.

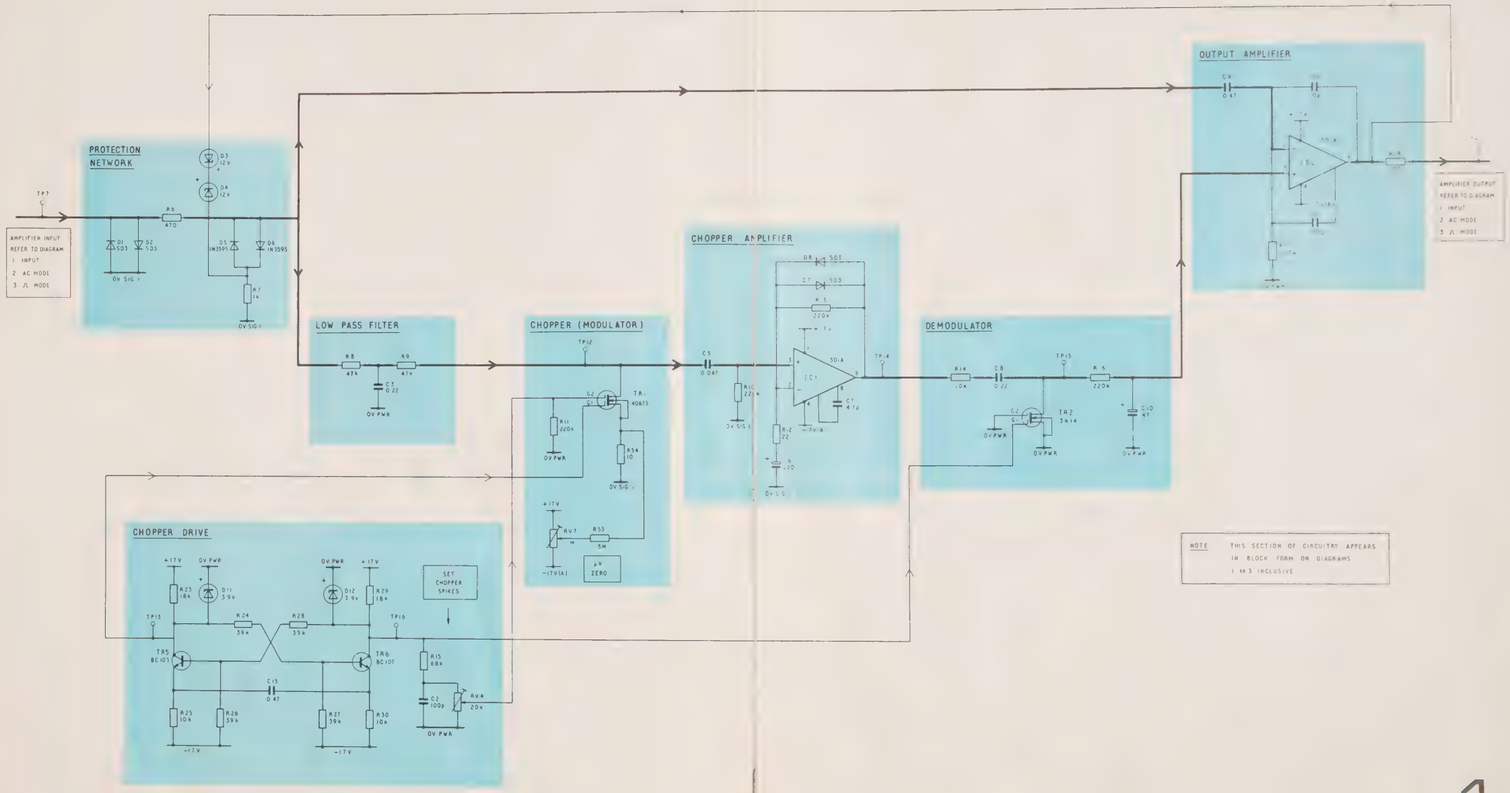
DEMODULATOR

The output from the CHOPPER AMPLIFIER is fed via C8 to TR2 where it is dc restored. The ac component is removed by filter R16 and C10. The dc component appears on C10 and is approx. 2.5×10^3 times the dc input applied to TR1 (CHOPPER).

OUTPUT AMPLIFIER

The ac component (>2Hz) of the input voltage is coupled directly via R17/C9 to the inverting input of the amplifier while the dc component on C10 (DEMODULATOR) is added into the non-inverting input.

The output is applied to the PROTECTION NETWORK which limits the overall amplifier output to within ±12V.



1A

COMMON AMPLIFIER (CIRCUIT DIAGRAM)

INPUT ATTENUATOR

On the 10V, 100V and 700V ranges, relay RLA is energised to attenuate the input signal by a factor of 100. The input impedance is 1MΩ whether the attenuator is energised or not.

INPUT AMPLIFIER

This is a voltage follower stage isolating the input from the COMMON AMPLIFIER input resistor. Diodes D2/D3 in conjunction with R5 provide overload protection.

SUMMING JUNCTION

The applied input plus the feedback signals via R7/R8 in the MEAN SENSING FEEDBACK NETWORK are summed at this point, the 'virtual earth' of the COMMON AMPLIFIER. RV2 scales the input signal so that the final displayed value on the LED module represents the rms (root-mean-square) value of the applied input assuming a pure sine-wave shape.

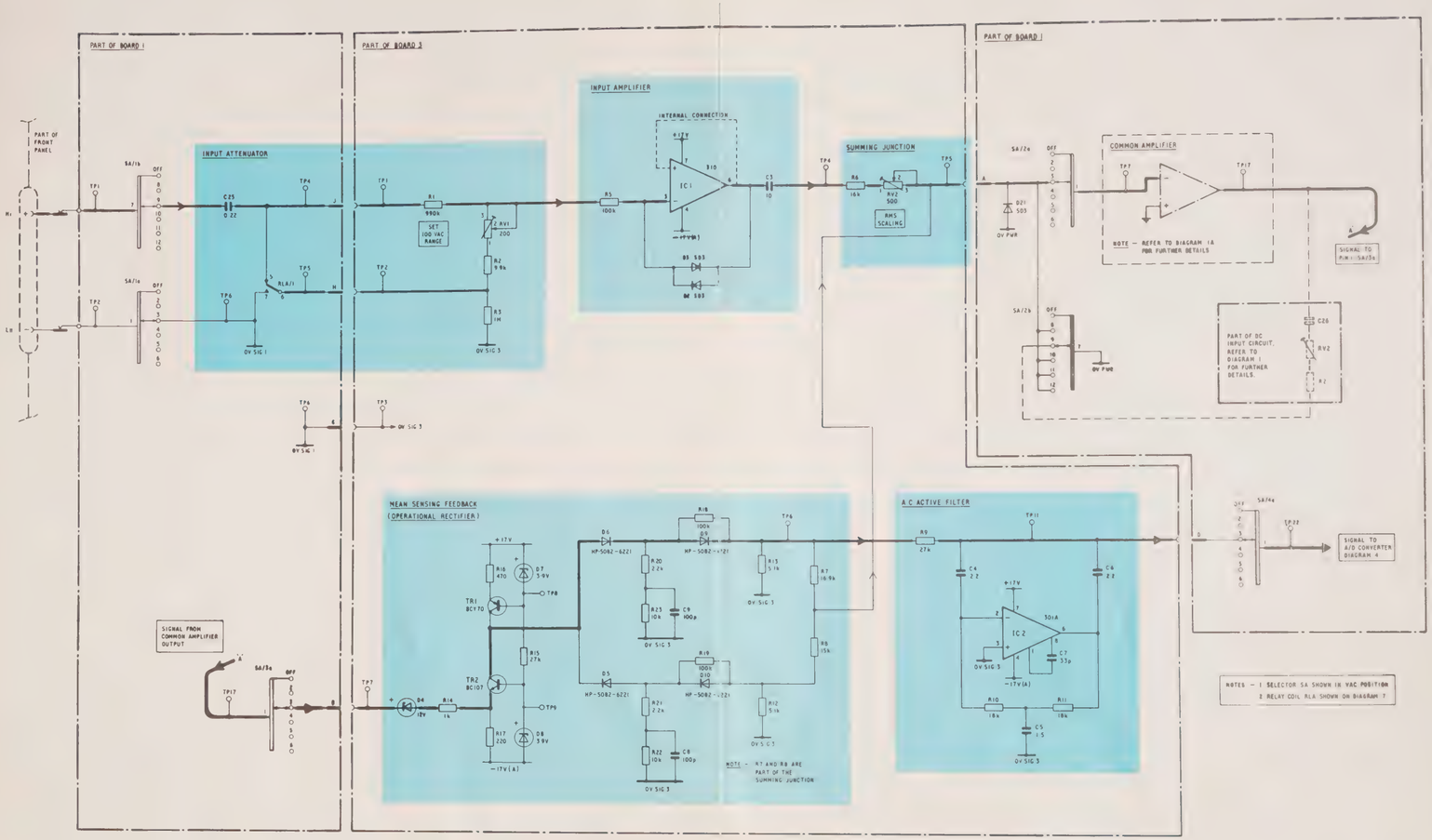
MEAN SENSING FEEDBACK NETWORK

The output of the COMMON AMPLIFIER (DIAGRAM 1A) drives the complementary common base stage formed by TR1/2. Positive half-cycles are fed back to the 'virtual earth' via D6/D9 and precision resistor R7. Negative half-cycles are fed back via D5/D10 and R8. Only the positive half-cycles at TP6 are taken for digital conversion.

R20/R23/C9 and R21/R22/C8 are shaping networks which improve frequency response at low signal levels.

AC ACTIVE FILTER

IC2 is connected as a low-pass active filter to remove high frequency components from the rectified ac signal. The filter has a nominal cut-off frequency of 4Hz and provides at least 60 dB/Decade attenuation.


PART OF BOARD 1
PART OF BOARD 2
PART OF BOARD 1
INPUT ATTENUATOR
INPUT AMPLIFIER
INTERNAL CONNECTION
SUMMING JUNCTION
COMMON AMPLIFIER
MEAN SENSING FEEDBACK (OPERATIONAL RECTIFIER)
A.C ACTIVE FILTER
SIGNAL FROM COMMON AMPLIFIER OUTPUT
SIGNAL TO A/D CONVERTER DIAGRAM 4
NOTES - 1 SELECTOR SA SHOWN IN VAC POSITION
2 RELAY COIL RLA SHOWN ON DIAGRAM 7

2

A.C. MODE (CIRCUIT DIAGRAM)

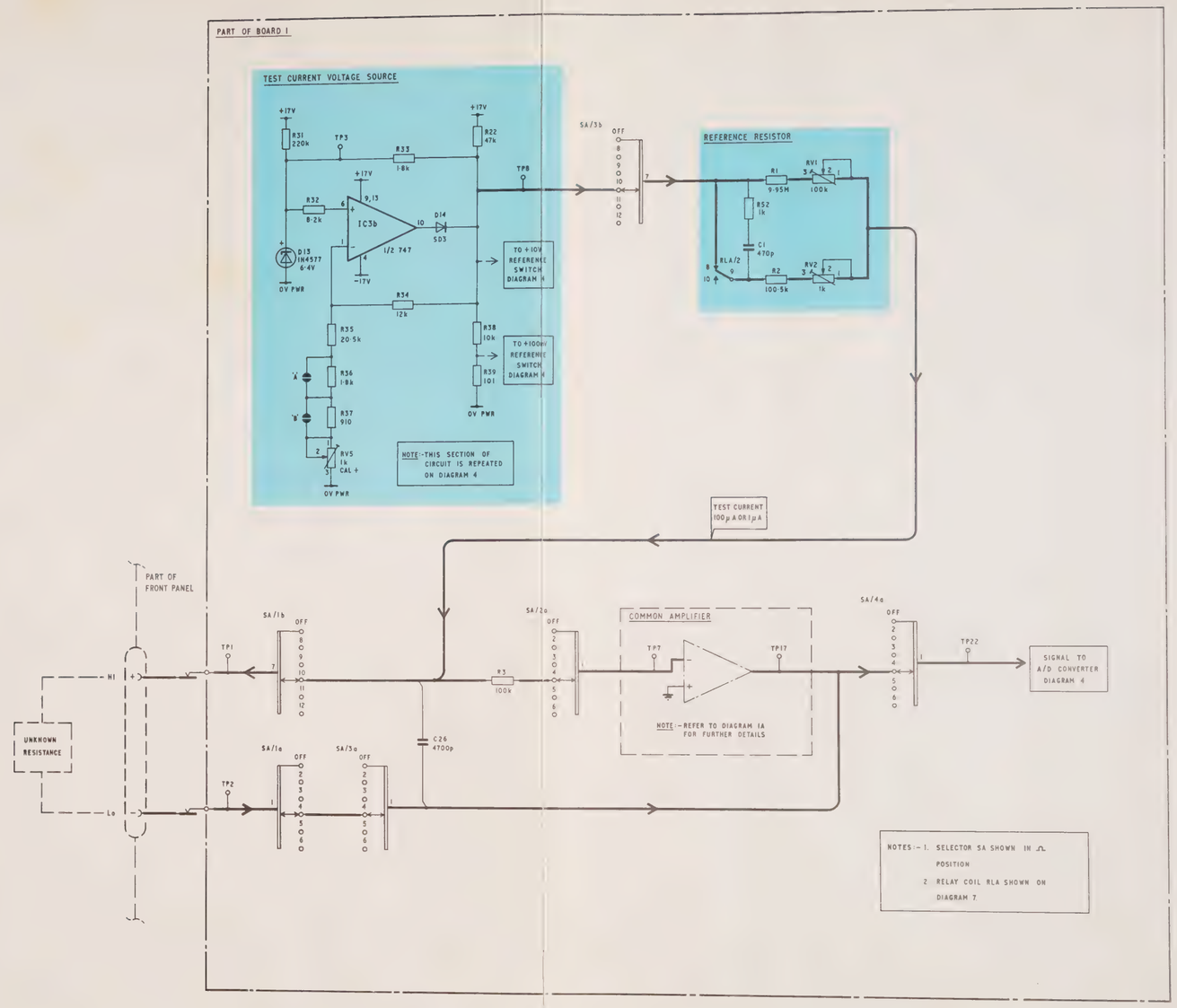
TEST CURRENT VOLTAGE SOURCE

In this mode of operation, the + 10.000V at TP 8 is used to provide a constant potential which, in conjunction with the REFERENCE RESISTOR, forms the appropriate test current (100 or 1μA) used to form a potential drop proportional to the unknown resistance. (This circuitry is repeated for reference only, refer to DIAGRAM 4 for detailed circuit description).

REFERENCE RESISTOR

These resistors are normally used as the DC ATTENUATOR network. When 'Ω' is selected, they define the test current used to measure resistance.

When relay RLA is energised, the test current is approx. 1μA.



OHMS MODE (CIRCUIT DIAGRAM)

3

SUB-SECTION 3b Digital

This sub-section deals with the DIGITAL section of the instrument whose primary function is to convert the dc analogue input into digital form.

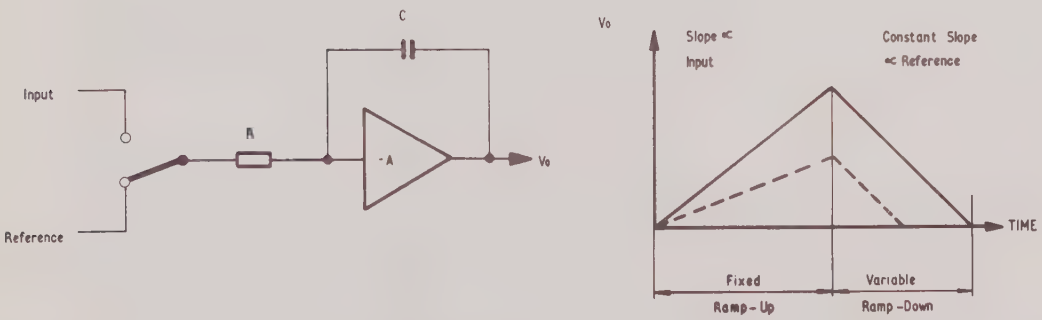
TRIPLE RAMP DIGITAL CONVERSION

Introduction

The triple ramp technique of analogue to digital conversion may be considered as a refined version of the well known dual ramp technique with the addition of a third ramp. This third ramp (known as fine ramp-down) acts like a 'vernier' upon the usual ramp-down period.

Basic Principles of Operation

Examination of the following simplified circuit diagram serves to illustrate the principles used to perform analogue to digital conversion in this instrument.



BASIC DUAL-RAMP SYSTEM

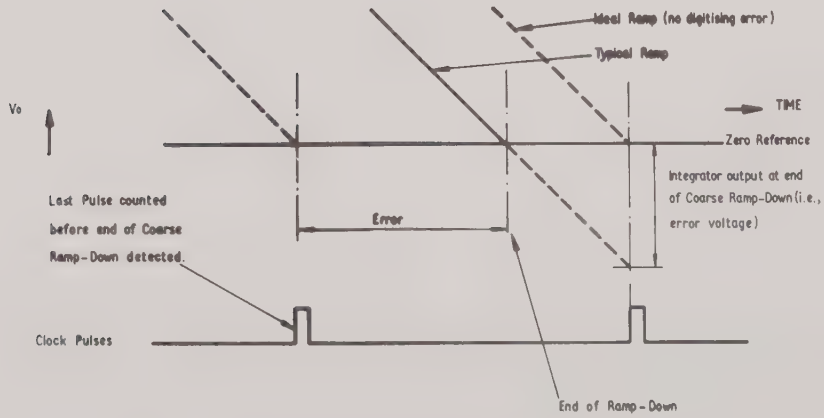
When the integrator is connected to the input its output 'ramps-up' at a rate which is proportional to the value of the input. After a fixed time the switch changes over and connects the reference inplace of the input. It is so arranged that the reference voltage is of opposite polarity to that of the input, so that the integrator output now 'ramps-down' at a defined rate which is determined by the value of the reference.

If the ramp-up period is made constant by using a clock pulse generator to gate the input switch, the number of pulses produced during the 'ramp-down' period, the length of which is controlled by the slope of the reference voltage, will be directly proportional to the applied input.

Since both ramp-up and ramp-down periods are related to a common timebase, any variations of clock frequency do not affect the reading.

In the DMM, the reference voltage used during this 'ramp-down' period (known as 'coarse ramp-down') is actually 10V, so each ramp-down pulse with a 'full-house' counter length of 10,000 will represent 1mV. The total number of pulses collected between the end of ramp-up and the point where the integrator output was driven to zero is a direct measure of the applied input voltage to within 1mV.

Looking at a greatly magnified view of the integrator output waveform at the point where the integrator output passed through zero, it can be seen that there is an inherent digitising error within the system, the magnitude of which can be 1mV.



If we allow the integrator output to continue beyond zero until the next clock pulse, the integrator capacitor will be charged to a level representing the difference between 1mV and the true measured input.

By adding two extra less significant decades to the counter, the minimum decade would represent 10μV. If we complement* the counter and then re-organise it such that it counts down to zero when driven by further clock pulses, by changing the ramp-down rate, the final count overall could represent the applied input when the integrator output again passes through zero.

In the DMM, this second ramp-down reference voltage is 100mV so that each new clock pulse will represent 10μV. In order to drive the integrator output to zero, the new ramp-down reference polarity is made opposite to the coarse ramp-down polarity. This third ramp is known as 'fine ramp-down'.

It can be seen that the final measurement could, in theory, be within 10μV of the applied input.

* COMPLEMENTING

The action of complementing a number within a counter can be followed by referring to the following example.

We have a hypothetical counter capable of holding a total count of 100 pulses. If we count say 60 input pulses, the number of pulses still required to 'fill-up' the counter will be 100-60 i.e. 40. It is this number which is defined as the complement of the number 60 in this example.

MEASUREMENT CYCLE DRIVES

Introduction

All stages of analogue to digital conversion are controlled by IC1-board 2, whose outputs turn on or off appropriate FET switches to select the appropriate sections of circuitry required at each stage of a measurement cycle.

Electrical Arrangement

There are eight cycle control drive outputs as follows:-

IC1-pin 11	Drift Correct
pin 12	Earth Clamp
pin 13	Spoiler
pin 14	Neg. Fine Reference
pin 15	Pos. Fine Reference
pin 16	Neg. Coarse Reference
pin 17	Pos. Coarse Reference
pin 18	Input Switch

During a typical measurement cycle, each of these pins will assume the states shown in Table 3B-1. The Pause periods 1-4 are for internal use within the integrated circuit to allow time for internal re-organisation of the counter, range selection and other tidying up operations required. The duration of these periods will change depending upon the range, length of ramp-down, spoiler time etc. so differing pause periods should not be interpreted as indications of faulty operation.

Table 3B - 1 Control Cycle Sequence

L = low ⩽ - 16V H = high ⩾+ 8V

IC1 - Board 2

Period	11	12	13	14	15	16	17	18
Drift Correct	L	L	H	H	H	H	H	L
Pause 1	H	L	H	H	H	H	H	L
Ramp-up	H	H	H	H	H	H	H	L
Spoiler Period	H	H	L	H	H	H	H	L
Pause 2	H	L	H	H	H	H	H	L
Coarse Ramp	H	L	H	H	H	H*	L*	H
Pause 3	H	L	H	H	H	H	H	L
Fine Ramp	H	L	H	L*	H*	H	H	H
Pause 4	H	L	H	H	H	H	H	L

Levels marked * will be inverted when the applied signal input is negative (with respect to the - terminal on the front panel).

AUTO-RANGING

Introduction

The DMM is fully auto-ranging for all modes of operation except measurement in the PROBE position which is a fixed current range. Range switching is divided into two parts, basic range selection and/or attenuator switching.

Range Selection

Each of the ranges are coded with a letter, the actual range depicted by each being dependant upon the measurement mode selected (refer Tables 3B - 2 to 4).

The basic ranges are coded A, B and C and progress in decade steps with A the highest. A, B or C followed by the letter R indicates the basic range together with the 100/1 attenuator stage, making a range selection with a full scale reading 100 times greater than that for the basic range alone.

Ranging up or ranging down occurs just after the fine ramp-down period in the measurement cycle, and unless a range change decision occurs, the range in use will remain constant for the remainder of the cycle.

Range-up Sequence

A range-up decision will occur if the total count at the end of fine ramp-down in the counter equals or exceeds 1.1 times that count which corresponds to the nominal full-scale count for the particular range in use. Take for example the 1V range, a range-up decision occurs if the measured voltage is 1.1 volts or higher, making 1.099V the highest voltage which will not cause a range-up decision.

Range-down Sequence

A range-down decision will occur if the total count in the counter after a measurement falls below 0.1 times that which corresponds to nominal full-scale count except when the particular range in use is the lowest for the mode of operation. In this instance, operation will be maintained on that range for all readings down to zero. Therefore for all but the lowest of a group of ranges 0.1000 times the nominal full-scale value is the lowest reading which will not cause a range-down decision.

Table 3B-2 Voltage Measurement Coding

Nominal Range	Range of Voltages Displayed	Range Coding DC	AC
1000V	1099.0 to 100.0V	AR	AR
100V	109.99 to 10.00V	BR	BR
10V	1.0999 to 1.0000V 999.9 to 100.0 mV	B	B
100mV	109.99 to 0.00 mV	C	C

Table 3B-3 Resistance Measurement Coding

Nominal Range Ω	Range of Resistances Displayed	Range Coding
10M	10999 to 1000 K	AR
1M	1099.9 to 100.0 K	BR
100K	109.99 to 10.00 K	A
10K	10.999 to 1.000 K	B
1K	1.0999 to 1.0000K 999.9 to 0.0	C

Table 3B-4 Current Measurement Coding

Nominal Range	Range of Current Displayed	Range Coding
1000μA	1099.9 to 100.0μA	A
100μA	109.99 to 10.00μA	B
10μA	10.999 to 0.000μA	C

Range Switching (DIAGRAM 5)

The input signal to the INTEGRATOR may or may not be rescaled by means of changing the effective input resistance. When Range A is selected (i.e. Ranges B/C not turned on) the signal is applied through R40 (IM). When Range B is selected, the effective input resistance will be 100K (IM//100K≃100K) thus the integrator input signal will be rescaled by a factor of 10. Similarly when Range C is selected, the effective input resistance will be 10K (IM//10K≃10K) thus the integrator input signal will be rescaled by a factor of 100. By this method, the input dynamic range of the INTEGRATOR maybe 0-11V, 0-1V or 0-110mV respectively. For inputs above 11V, the attenuator relay RLA (DIAGRAM 7) provides a 100/1 attenuation factor to bring the input signal to within the 0-11V dynamic range of the A/D Converter.

RF (PROBE) Selection

When this mode of operation is selected, the range outputs of IC1 - board 2 select voltage range B, all other range combinations will be inhibited.

SPECIAL INSTRUCTIONS

F.E.T.'s Ref. TR18/19 (P.C.B. No. 2)

These transistors are mounted on small blue pads made of Beryllium Oxide.

GREAT CARE SHOULD BE TAKEN NOT TO CRUSH OR CUT THESE PADS DUE TO THE HIGHLY TOXIC NATURE OF BERYLLIUM OXIDE DUST.

Whenever installing or removing these components, it is essential that the wire leads are always shorted together with wire (e.g. fine fuse wire) to protect the device from static breakdown when handled.

Selected F.E.T.'s TR13-15 & 21 (P.C.B. No. 2)

Whenever any one of these components are replaced, it is essential that a device with the same colour coding is used or alternatively, replace the whole set.

Note Reference should be made to the selection procedure detailed in the APPENDIX section of this manual.

IC1 - P.C.B. No. 2 (MOS-LSI) Integrated Circuit

This 40-lead dual-in-line ceramic package contains the digital circuitry used to control the measurement cycle, count and gate clock pulses, provide signals to drive the LED display and to rescale the Integrator during auto-ranging.

Details of all pin connections, functions and on which diagram each pin may be located are shown in Table 3B-5. It should be noted that IC1 is not shown as a separate item but only by means of square boxes such as those shown on DIAGRAM 4.

WARNING

Before attempting to remove this integrated circuit, ensure that all power supplies are switched off.

Table 3B-5 IC1 (P.C.B. No. 2) Pin Locations

Pin No.	Function	Diagram
1	V_{CC} + 12V supply	8
2	100mV Range (C)	5
3	1V Range (B)	5
4	Probe (Mode) Selection	7
5	VAC (Mode) Selection	7
6	* Not Used	-
7	* Not Used	-
8	Polarity Detector	5
9	Mains Zero Command	7
10	Battery Operation	8
11	Drift Correct	5
12	Earth Clamp	4
13	Spoiler	5
14	Neg. Fine Reference (-100mV)	4
15	Pos. Fine Reference (+100mV)	4
16	Neg. Coarse Reference (-10V)	4
17	Pos. Coarse Reference (+10V)	4
18	Input Switch	4
19	Clock Input $\phi 1$	7
20	Clock Input $\phi 2$	7

CAUTION Pins marked * must not be connected to any adjacent pins or any other part of the p.c.b. circuitry.

Pin No.	Function	Diagram	
21	V_{DD} - 17V Supply -13	8	
22	* Not Used +10	-	
23	* Not Used +5 Rect Wave *	-	
24	5th Character 1·4V Rect As 23 *	6	O/P
25	4th Character As 24 *	6	
26	3rd Character As 24 *	6	"
27	2nd Character As 24 *	6	"
28	1st Character As 24 *	6	"
29	V_{EE} 0V Sig. 2 ○	1	
30	g/- Segment +6·4V M/S 2:1 switching	6	O/P
31	f/KΩ Segment As 30	6	
32	e/Ω Segment As 30	6	
33	d/mV Segment 6·4V Switching	6	
34	a/V Segment As 30	6	
35	c Segment As 30 *	6	
36	p/μA Segment As 30 M/S opposite	6	
37	b Segment 6·4V Varying space As readout changes	6	
38	Relay (RLA) Selection Varying *	7	"
39	μA (Mode) Selection 10V	7	
40	Ω (Mode) Selection 10V	7	

CAUTION Pins marked * must not be connected to any adjacent pins or any other part of the p. c. b. circuitry.

DISPLAY

Introduction

The type of display used in this instrument is a light emitting diode (L.E.D.) 7-bar segment, time-shared type arranged to display 5 digits and a polarity sign.

7-bar Segment Format

Each of the possible digits 0-9 are displayed using the universally accepted 7-bar segment format. In order to display a digit, a specific group of bars, each comprising a light emitting diode, is energised.

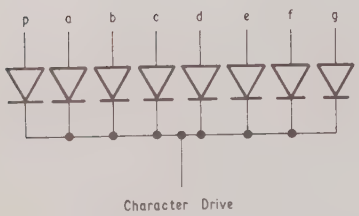
Each bar has been referenced with a letter a-g, and are arranged in the form of a figure 8 as shown below.

For example, suppose we wish to display the digit 2. In this case, bars a, b, d, e and g would be energised, all other bars being left de-energised.

The actual bars used to represent each digit are shown on DIAGRAM 6.

General Organisation of Display

The display used can display up to 5 characters, each of which comprises a 'diode tree' as shown below.



Each diode of a 'tree' corresponds to a specific bar as detailed above.

Note: The decimal point for each character is positioned to the left and will be energised whenever the 'p' bar is called for at the same time as the appropriate character.

In the DMM, each of the 5 possible characters are energised via the appropriate CHARACTER DRIVER (DIAGRAM 6) in sequence. In order that a particular digit may be displayed, the appropriate 7-BAR SEGMENT DRIVERS (DIAGRAM 6) are energised. For a group of diodes to light, both the segment and character drives must be present at the same time but since only one character drive will be present at any one time only one character will ever be on. It should be noted that the 1st character is incomplete, the surplus segments of which are arranged as the UNITS ANNUNCIATOR DISPLAY (DIAGRAM 6).

The polarity window will only display negative, absence of display signifying a positive applied potential to the instrument. When 'VAC' is selected, no sign is displayed.

LOGIC ELEMENTS

NAND Gates (DIAGRAM 7 - DIVIDE BY 4)

Elements IC4a and IC4b are logic elements performing a NAND function (positive logic) for which the following truth tables apply:

IC4a Pin No.	1	2	3
	H	H	L
	L	H	H
	H	L	H
	L	L	H
IC4b Pin No.	**4**	**5**	**6**
	H	H	L
	L	H	H
	H	L	H
	L	L	H

Logic Levels

H = -11V to - 14.5V

L = -16.5V to - 17.5V

IC4 comprises 4 elements, two of which are not used in this equipment.

D - type Bistable (DIAGRAM 7 - DIVIDE BY 4)

Elements IC5a and IC5b are logic bistables (flip-flops) performing a D-type function (positive logic) for which the following rules apply:

i. Whenever the CK (Clock) input goes high (positive logic), the Q output assumes the same state as that present on the D input.

ii. Whenever the CK input is low, the D input level has no effect.

iii. The $\overline{Q}$ output is always the complement of the Q output.

Voltage Levels

Care should be taken when investigating this section of circuitry not to short any of the logic element connections to the 0V rails, since this action could apply a minimum level of -12V to the element and almost certainly damage it. It is recommended that the -17V rail should be used as a return path for test equipment and make appropriate adjustments to indicated readings.

TEST WAVEFORMS

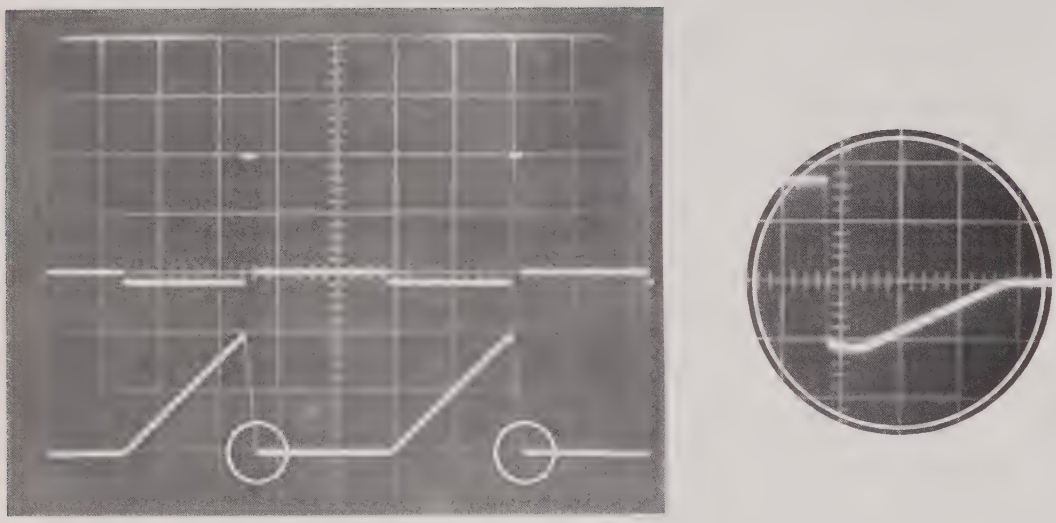
Frames 3B-1/2

Upper Trace

This shows a typical input waveform at the INTEGRATOR (DIAGRAM 5) 'virtual earth' input.

Lower Trace

A typical ramp-up waveform produced at the input of the X100 AMPLIFIER (DIAGRAM 5) at TP11. The small insert shows a typical fine ramp-down. Note that the coarse ramp-down cycle is shorter than that shown in the main trace for illustration purposes only.



Frame 3B-1 Typical INTEGRATOR Waveforms

Frame 3B-2 Typical INTEGRATOR Waveforms with AC interference

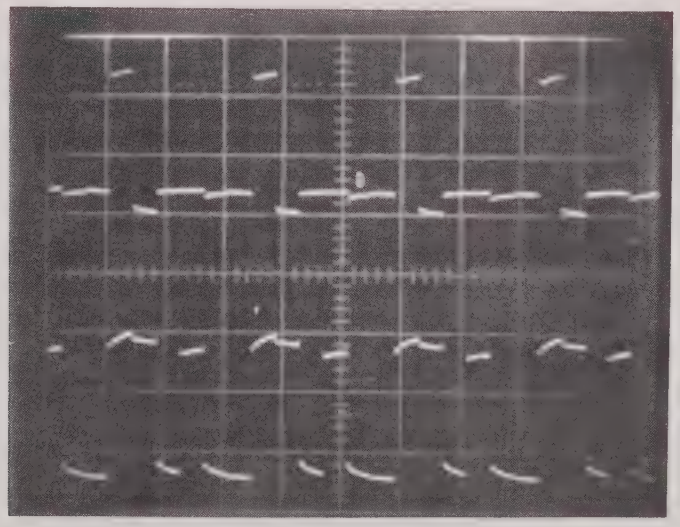
Frames 3B-3/4

Upper Traces

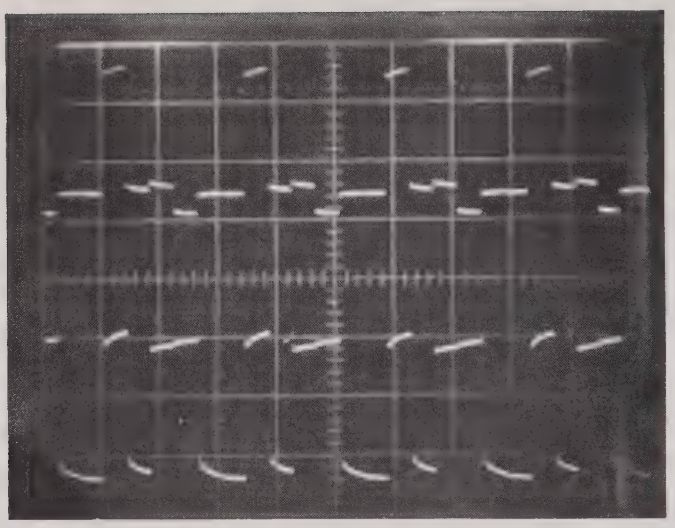
These traces illustrate typical CHARACTER DRIVER (DIAGRAM 6) outputs. Trace 3B-3, shows the 1st character output, trace 3B-4 the 3rd character output. It can be seen that the character output selected coincides with the lowest trace, all other outputs are due to pick-up and other switching transients.

Lower Traces

These traces illustrate typical 7-BAR SEGMENT DRIVER (DIAGRAM 6) outputs. Trace 3B-3, shows the selection of bar 'g' in the 1st character (i.e. the - polarity sign). Trace 3B-4 shows the 'a' bar output in the 3rd character, in this example the top of the figure 7. It should be noted that the only valid outputs are those which coincide with the appropriate character trace. If a particular bar has not been selected by the SEGMENT DRIVER, the trace will be pulled down when the character pulse occurs.



Frame 3B-3 1st Character + Segment 'g'



Frame 3B-4 3rd Character + Segment 'a'

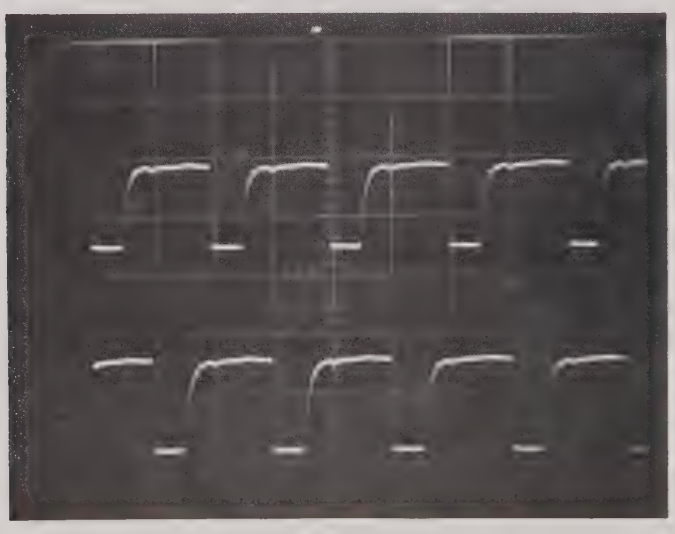
Frame 3B-5

Upper Trace

Typical output waveform at IC1-pin 19 of clock input phase $\phi 1$ - refer CLOCK DRIVERS (DIAGRAM 7).

Lower Trace

This is the clock input at IC1-pin 20 in phase $\phi 2$.



Frame 3B-5 Clock Waveforms

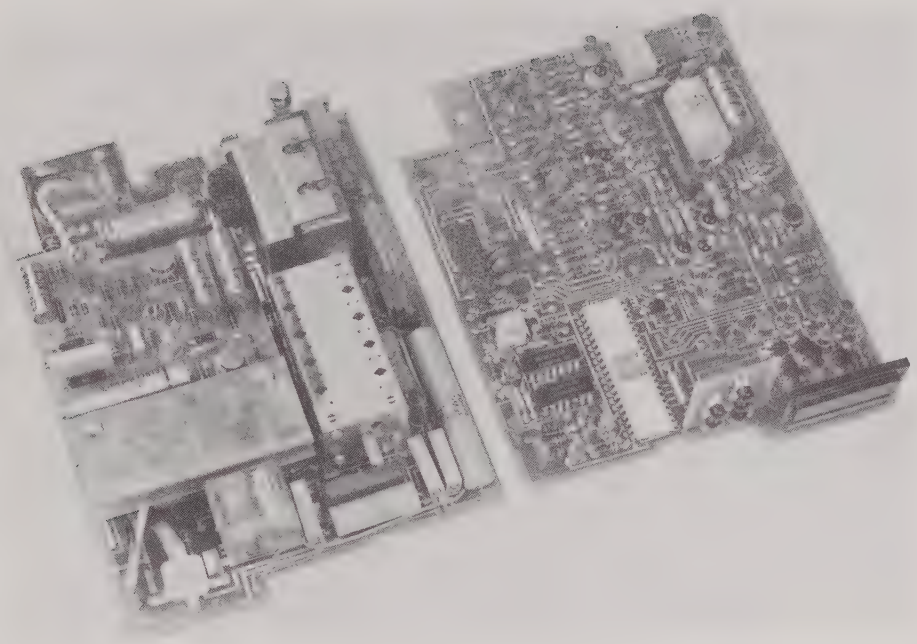


Figure 3B-1 Access to DIGITAL Section

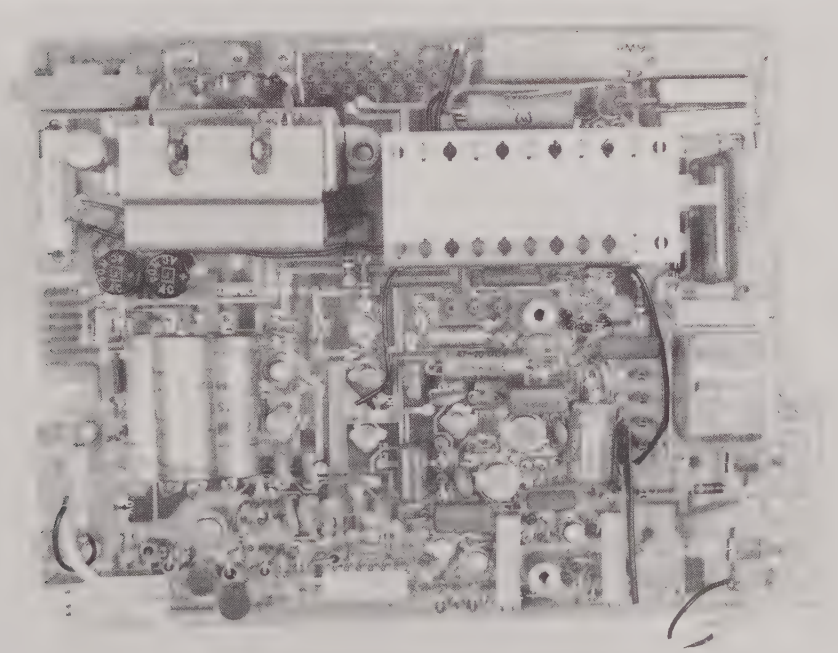


Figure 3B-2 (P. C. B. No. 1) General View (Top)

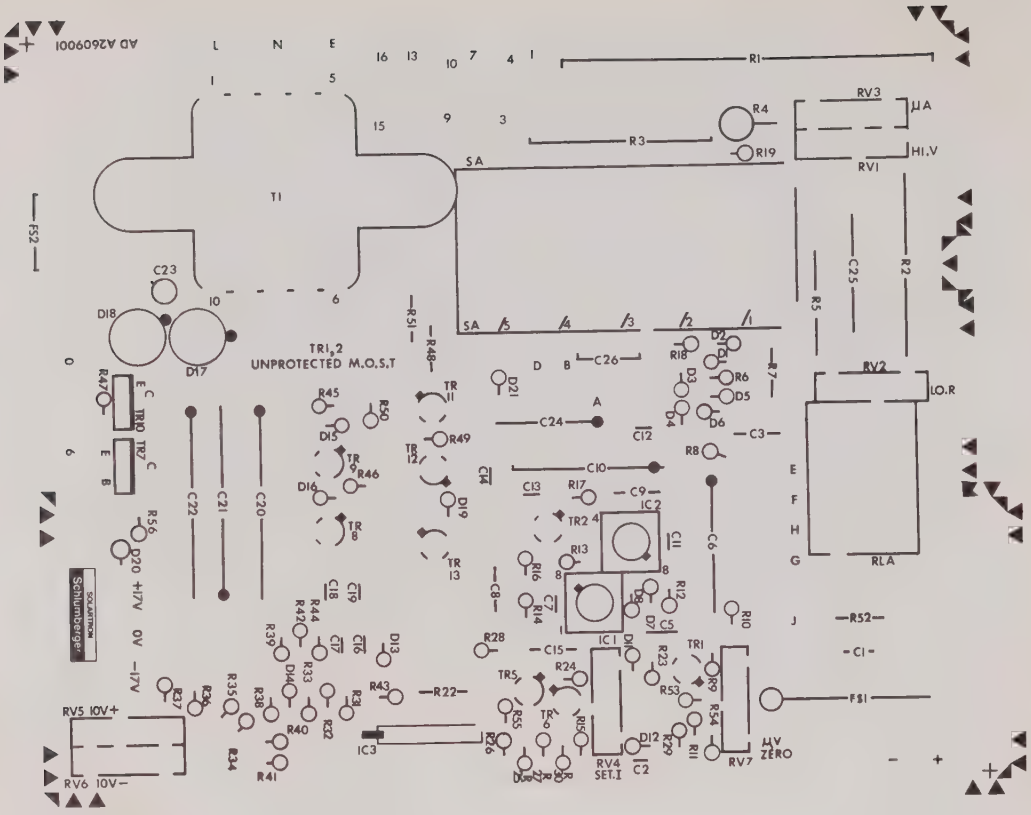
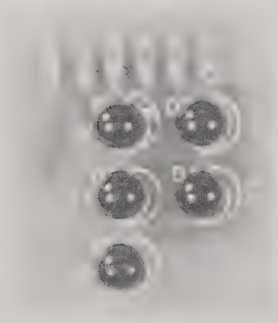
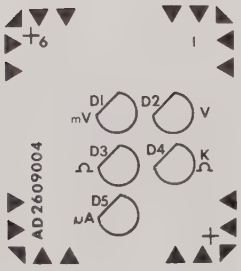


Figure 3B-3 (P.C.B. No. 1) Component Notation



(a) General View (Top)



(b) Component Notation

Figure 3B-4 (P.C.B. No. 4)

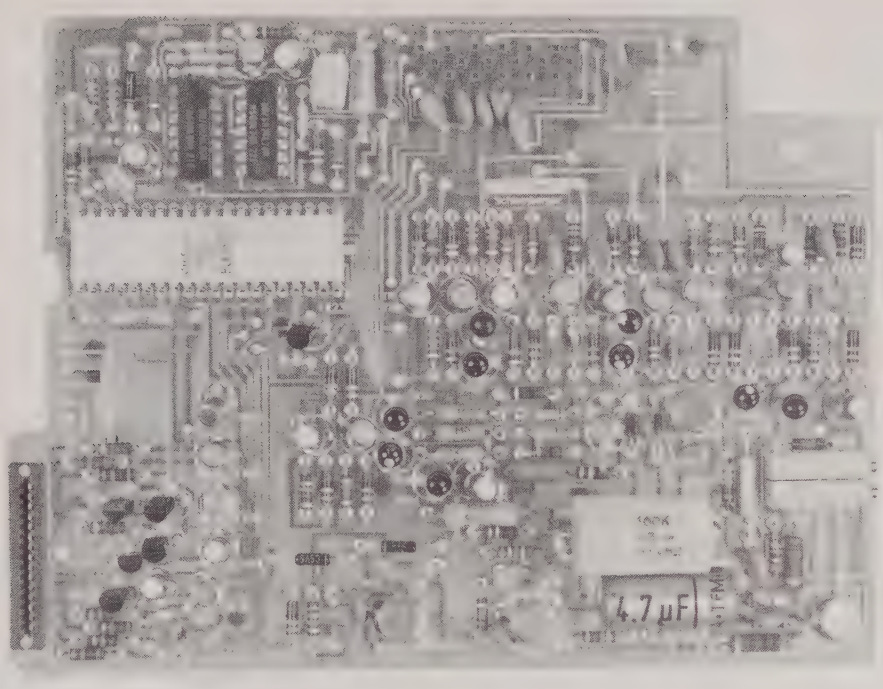


Figure 3B-5 (P.C.B. No. 2) General View (Top)

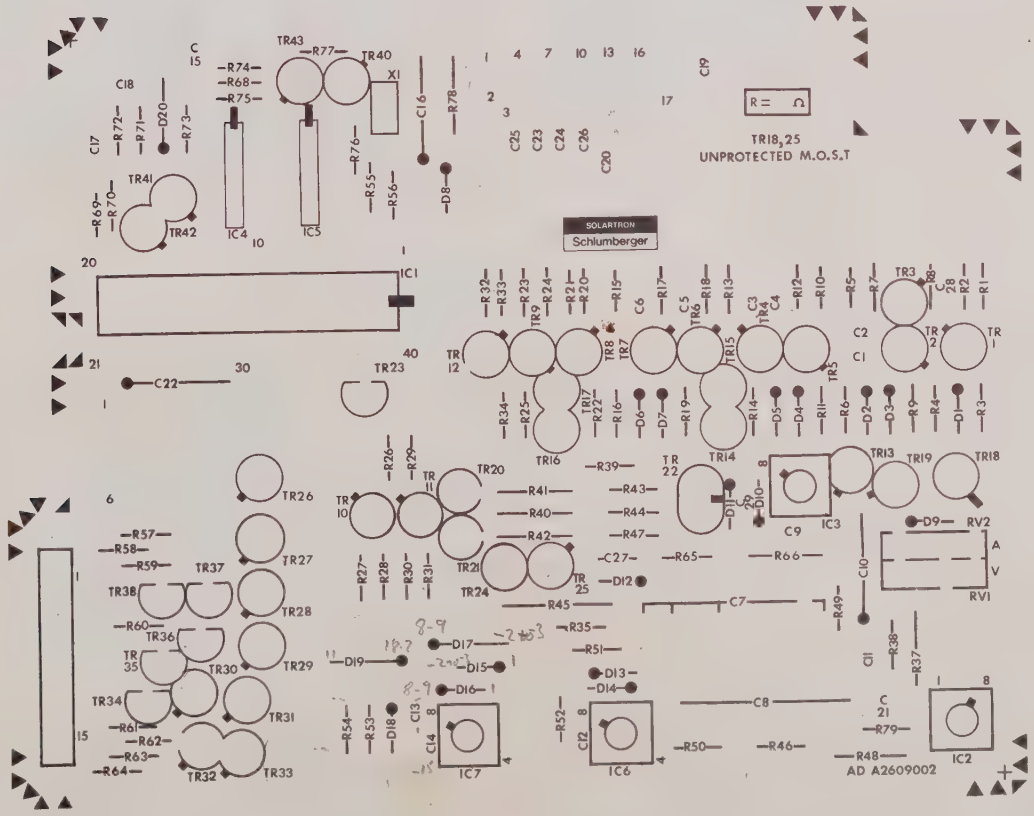


Figure 3B-6 (P.C.B. No. 2) Component Notation

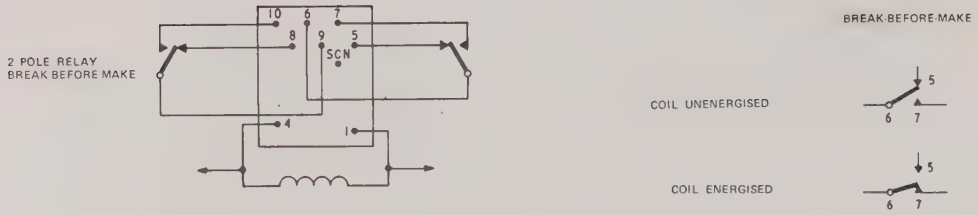


Figure 3B-7 Relay RLA

REFERENCE VOLTAGE SOURCE

IC3b is connected as a non-inverting amplifier amplifying the voltage of reference zener D13 to give + 10V adjusted by means of R36/37 and RV5 to give correct calibration. The output is +10.000V for use as a positive coarse reference. R38/R39 form a potential divider to provide +100mV for use as positive fine reference.

INVERTER

IC3a is connected as an inverter to produce -10.000V from the REFERENCE VOLTAGE SOURCE. RV6 is adjusted to compensate for resistor tolerances and any dc offset. R43/R44 form a potential divider to provide -100mV for use as negative fine reference.

EARTH CLAMP

During ramp-up, IC1-pin 12 goes high, thus via TR1 allowing TR18 to conduct to apply the unknown input signal to the A/D Converter. Similarly, TR19 is turned off thus unclamping the INPUT BUFFER AMPLIFIER from signal earth. At the end of ramp-up, IC1-pin 12 goes low, thus turning off TR18 and reclamps the INPUT BUFFER AMPLIFIER to earth via TR19.

INPUT BUFFER AMPLIFIER

A buffer stage providing input isolation to the INTEGRATOR (DIAGRAM 5). RV1 is provided for trimming out any internal voltage offset of IC2 while RV2 adjusts the input current compensation.

INPUT SWITCH

During ramp-up, IC1-pin 18 goes high, applying the unknown input signal to the INTEGRATOR (DIAGRAM 5). TR13 is chosen such that the F.E.T. switches TR14 or TR15 in the COARSE REFERENCE SWITCHES present equal input impedance to the INTEGRATOR (DIAGRAM 5) during both ramp-up and the appropriate coarse ramp-down period.

(Refer to the F.E.T. Selection Procedure in the APPENDIX of this manual for details of selection.)

NEG. COARSE REFERENCE SWITCH

If the COMPARATOR (DIAGRAM 5) detects a positive input signal during ramp-up, IC1-pin 17 goes high during the coarse ramp-down period. This turns on TR14 applying -10.000V as a negative reference input to discharge the level (proportional to the applied input signal) stored on the integrating capacitor C7 in the INTEGRATOR (DIAGRAM 5) during ramp-up.

NEG. FINE REFERENCE SWITCH

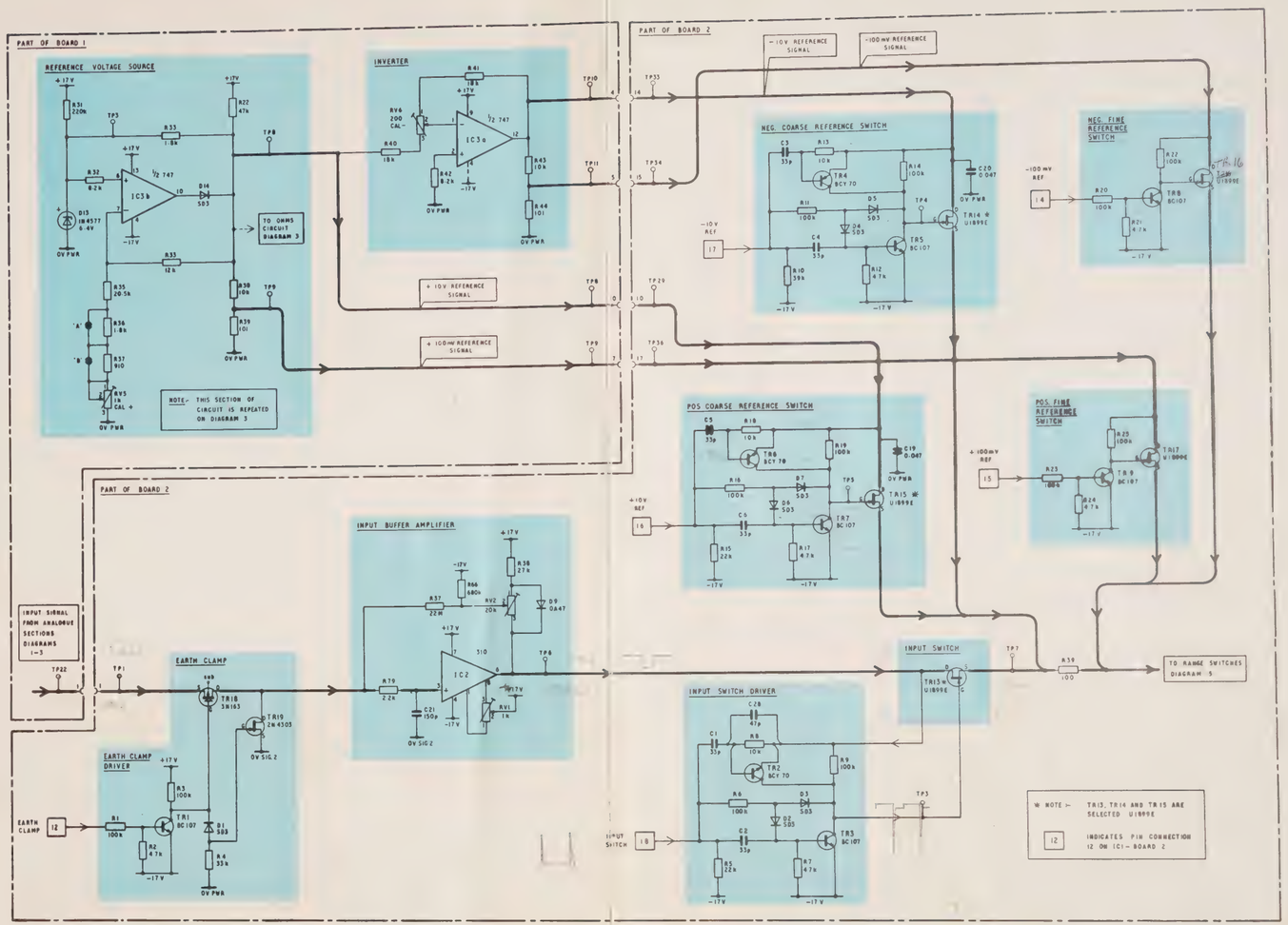
If the input signal was negative during ramp-up, IC1-pin 14 goes low, turning on TR16 during the fine ramp-down period to apply -100mV as a fine reference signal to the INTEGRATOR (DIAGRAM 5).

POS. COARSE REFERENCE SWITCH

If the COMPARATOR (DIAGRAM 5) detects a negative input signal during ramp-up, IC1-pin 16 goes high during the coarse ramp-down period. This turns on TR15 applying +10.000V as a positive reference input to discharge the level (proportional to the applied input signal) stored in the integrating capacitor C7 in the INTEGRATOR (DIAGRAM 5) during ramp-up.

POS. FINE REFERENCE SWITCH

If the input signal was positive during ramp-up, IC1-pin 15 goes low, turning on TR17 during the fine ramp-down period to apply +100mV as a fine reference signal to the INTEGRATOR (DIAGRAM 5).


PART OF BOARD 1
REFERENCE VOLTAGE SOURCE
INVERTER
TO OHMS CIRCUIT DIAGRAM 3
NOTE:- THIS SECTION OF CIRCUIT IS REPEATED ON DIAGRAM 3
PART OF BOARD 2
-10V REFERENCE SIGNAL
-100mV REFERENCE SIGNAL
+10V REFERENCE SIGNAL
+100mV REFERENCE SIGNAL
NEG. COARSE REFERENCE SWITCH
NEG. FINE REFERENCE SWITCH
POS COARSE REFERENCE SWITCH
POS. FINE REFERENCE SWITCH
INPUT BUFFER AMPLIFIER
INPUT SIGNAL FROM ANALOGUE SECTIONS DIAGRAMS 1-3
EARTH CLAMP
EARTH CLAMP DRIVER
INPUT SWITCH
INPUT SWITCH DRIVER
TO RANGE SWITCHES DIAGRAM 5
* NOTE :- TR13, TR14 AND TR15 ARE SELECTED U1899E
INDICATES PIN CONNECTION 12 ON IC1 - BOARD 2

A/D CONVERTER (CIRCUIT DIAGRAM) Sheet 1

4

INTEGRATOR

IC3 is connected as an operational integrator. The signal input is applied to one side of a differential stage formed by TR22. The other input is a dc level stored in the DRIFT CORRECT circuitry by C8. This maintains the 'virtual earth' of the Integrator at 0V with respect to the output of the INPUT BUFFER AMPLIFIER (DIAGRAM 4) and therefore eliminates drift. C9 is used to provide feed-forward compensation.

X100 AMPLIFIER

A X100 amplifier stage to enable the COMPARATOR to detect very low integrator outputs thus accurately defining the end of each ramp-down period.

COMPARATOR

The output of the X100 AMPLIFIER is compared with earth; for a positive input, the output of IC7 will be negative; similarly for a negative input, the output will be positive. The purpose of the Comparator is to detect when the input changes from one polarity to the other i.e. when the INTEGRATOR output passes through zero signifying the end of coarse or fine ramp-down as appropriate. The state of this output after completion of ramp-up determines the polarity of the applied coarse and fine reference drives used during the remainder of the measurement cycle. An output of $<+0.5$V corresponds to positive polarity. A level $>+10$V corresponds to negative polarity.

DRIFT CORRECT

Between the end of fine ramp-down and the start of the next ramp-up, IC1-pin 11 goes low, turns on TR25 and charges up C8 to the level of the combined offset errors of the INTEGRATOR and INPUT BUFFER AMPLIFIER (DIAGRAM 4) so that during the ramp-up and ramp-down periods, these offsets are compensated for.

SPOILER

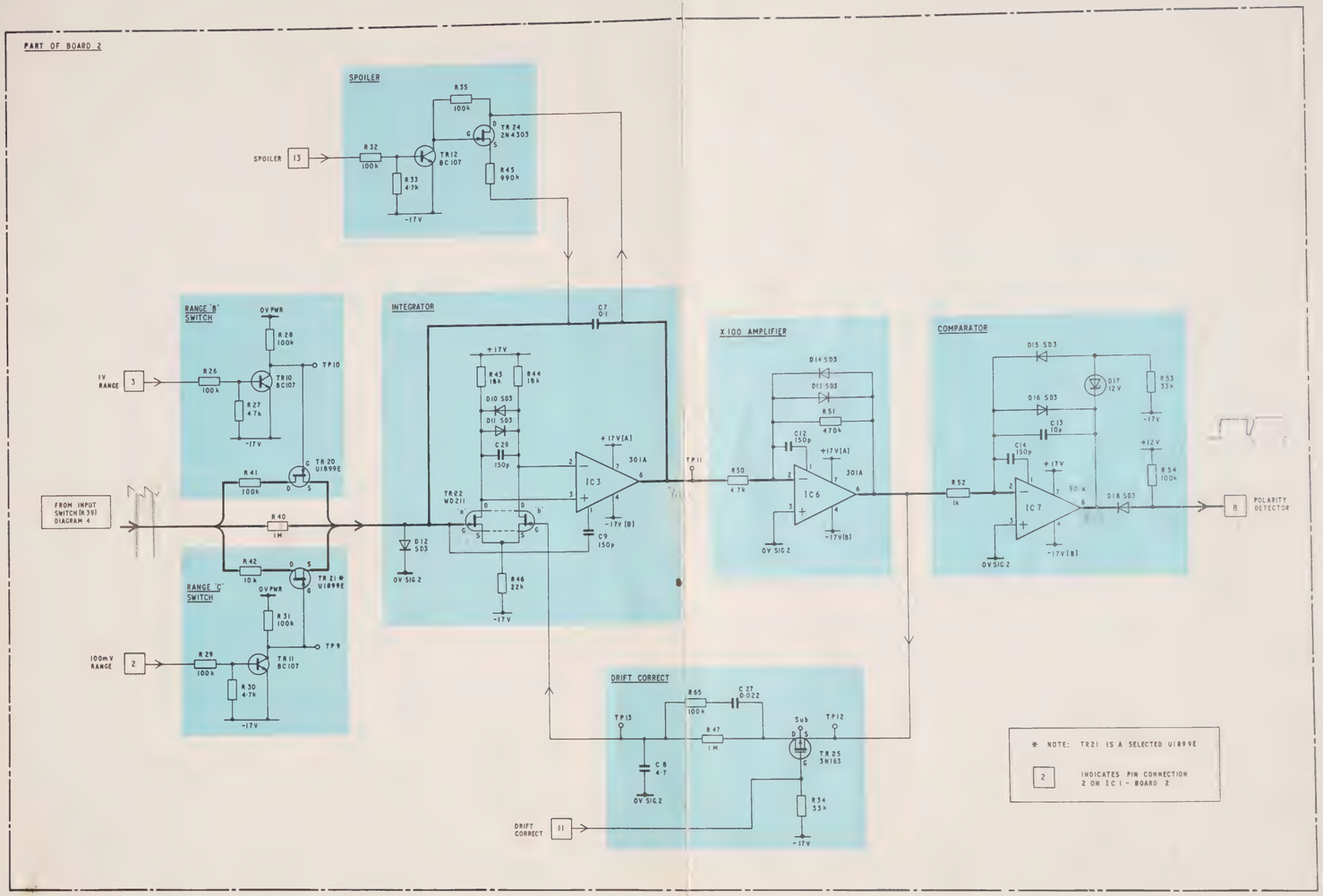
At the end of ramp-up, IC1-pin 13 goes low, TR24 conducts to allow a small proportion of the INTEGRATOR output to be applied to TR22b to introduce a small correction to compensate for interference errors.

RANGE 'C' SWITCH

Whenever IC1-pin 2 goes low, TR21 conducts so that the input impedance of the INTEGRATOR will be effectively 10KΩ. (Refer to Tables 3B-2 to 4 for details of actual ranges selected in each mode of operation.)

RANGE 'B' SWITCH

When IC1-pin 3 goes low, TR20 conducts so that the effective input impedance of the INTEGRATOR will then be 100KΩ. (Refer to Tables 3B-2 to 4 for details of actual ranges selected in each mode of operation.)



5

A/D CONVERTER (CIRCUIT DIAGRAM) Sheet 2

7 - BAR SEGMENT DRIVERS

When the appropriate IC1 output goes high, the appropriate segment in the display will be lit-up provided the appropriate character has been selected. For example, at one instance, all the 'g' bars will be selected if IC1-pin 30 goes high, but since only one CHARACTER DRIVER will be on, only the 'g' bar of that character will be lit-up.

CHARACTER DRIVERS

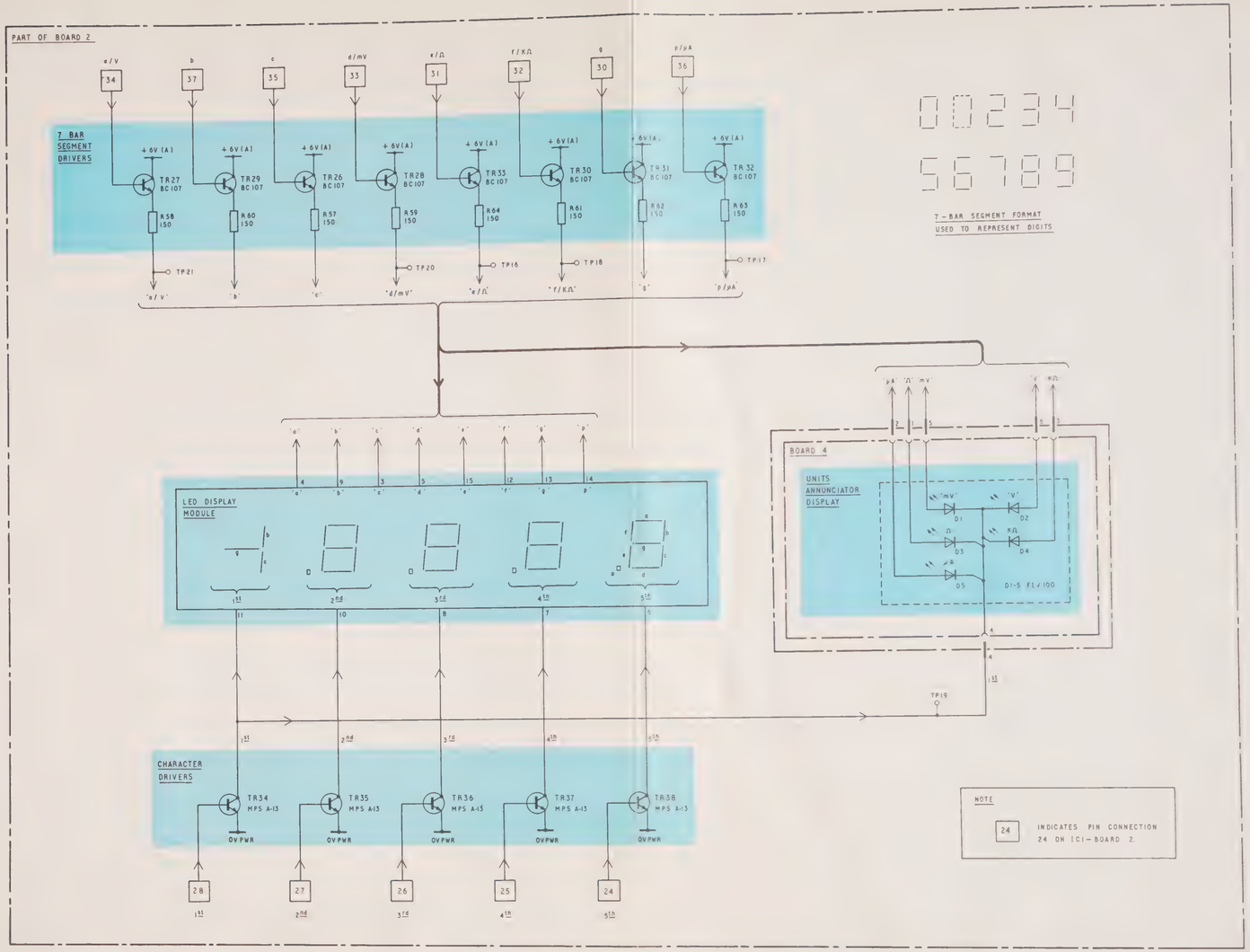
The characters are displayed serially, i.e. first the most significant, then the next and so on. Whenever the appropriate character input goes high, all the selected segments within that character will be energised and will light-up.

LED DISPLAY MODULE

This display is composed of light emitting diodes (L.E.D.) arranged in a matrix. Whenever the appropriate character and segment lines go low together, the appropriate diode glows.

UNITS ANNUNCIATOR DISPLAY

Whenever the appropriate 7-BAR SEGMENT DRIVER output goes low together with the common cathode line going low via TR34 (CHARACTER DRIVERS), the appropriate indicator will light-up.



6

DISPLAY (CIRCUIT DIAGRAM)

CLOCK OSCILLATOR

A stable crystal controlled oscillator producing a source of timing pulses at 404kHz.

DIVIDE BY 4

A binary divider stage dividing the input signal by a factor of 4. The resultant output frequency of each output is 101kHz. Reference should be made to the text for details of the phase relationship between each output.

CLOCK DRIVERS

The input clock pulse train (101kHz) drive TR41 and TR42 on and off forming output pulses between +11.5V and -17V (max. amplitude = 28.5V) which are of sufficient amplitude to drive the clock inputs of IC1 (MOS-LS1 circuit).

MODE SELECTION

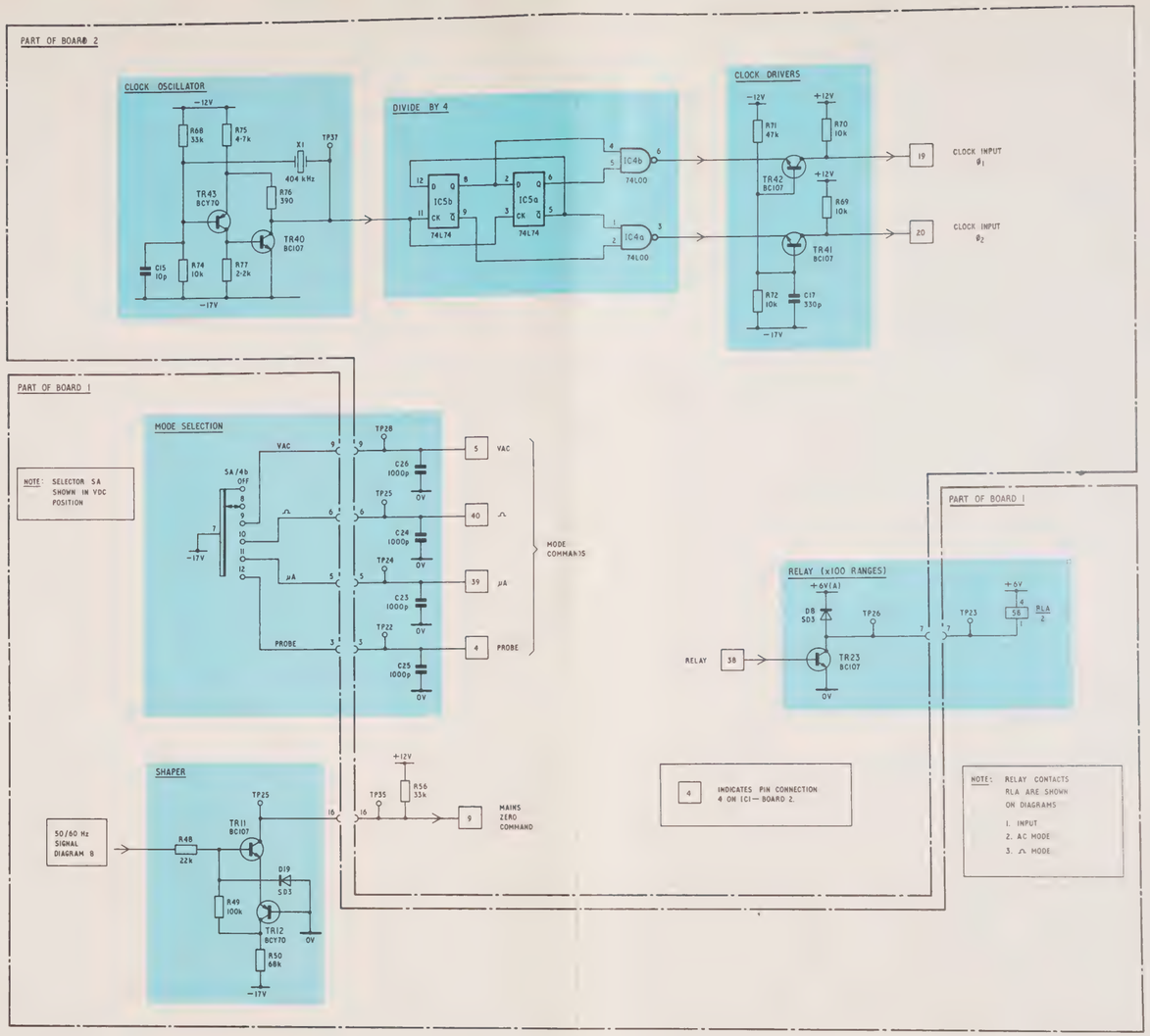
At each switch position, the appropriate input of IC1 will be held low thus selecting the appropriate mode. When VDC is selected, all the mode inputs go high and the DC mode is assumed.

RELAY (X100 RANGES)

Whenever IC1-pin 38 goes high, relay RLA is energised to provide a 100 to 1 attenuation of the input signal. Diode D8 provides a discharge path for the relay coil back emf when the relay is turned off.

SHAPER

When the DMM is used on mains supplies, a small proportion of the incoming mains frequency is sampled; the signal is clipped and is used by IC1 (MOS-LS1 circuit) to provide mains zero timing reference points.



TIME/CLOCK/MODE (CIRCUIT DIAGRAM)

SUB–SECTION 3c Power Supplies

This sub-section deals with the POWER SUPPLIES section of the instrument whose primary function is to provide all the internal dc levels required to operate the instrument.

POWER SUPPLIES

General Arrangement

This section of circuitry provides all the dc voltage levels required to operate the instrument using either the ac supply or (if fitted), power provided by the optional accessory unit 70401.

0V Rails

Within the instrument, the common return paths (0V rails) are carefully separated to reduce interference. Care should be taken not to short these rails together other than where shown.

Solder Pads C and D (P.C.B. No. 1)

These pads enable the user to isolate the appropriate stabilised supply from the associated section of circuitry. Since these pads are continuations of the printed circuit copper work, care should be taken not to overheat these connections causing the track to 'left' away from the board.

Voltage Levels Usage

The following tables may be used to locate which voltage rails appear on which circuit diagrams.

Table 3C-1 Voltage Rail Usage

Nominal Voltage	Test Point	Diagram
+6V	Bd1 - D18 (+) Bd2 - TP30	7, 8 8
+6V(A)	Bd2 - TP15	6, 7, 8
-6V	Bd1 - D18 (-)	8
+17V	Bd1 - TP18/19 Bd2 - TP31 Bd3 - TP10	1A, 3, 4, 8 4, 5, 8 2, 8
+17V(A)	Bd2 - IC3 pin 7	5, 8
+12V	Bd2 - C16 (+)	5, 7, 8
-17V	Bd1 - TP20/21 Bd2 - TP27	1A, 3, 4, 7, 8 4, 5, 7, 8
-17V(A)	Bd1 - C24(-) Bd3 - TP12	1A, 8 2, 8
-17V(B)	Bd2 - C10(-)	5, 8
-12V	Bd2 - TP2	7, 8
0V PWR (Power)	Bd1 - T1 pin 8 Bd2 - TP27	1A, 2, 3, 4, 7, 8 4, 5, 6, 7, 8
0V Sig. 1	Bd1 - TP6	1A, 2
0V Sig. 2	Bd2 - TP38	4, 5
0V Sig. 3	Bd3 - TP3	2

All 0V Rails appear on DIAGRAM 1

Figure 3C-1 Access to POWER SUPPLIES Section

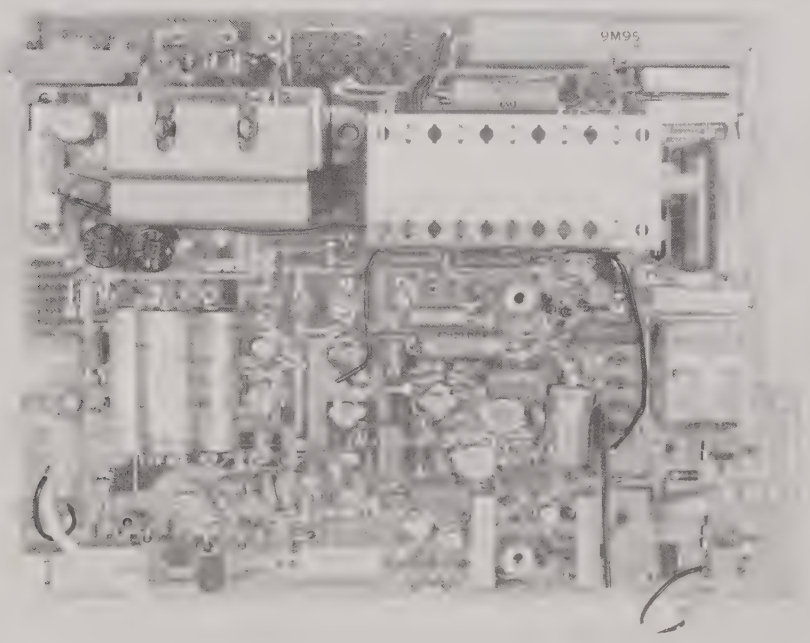


Figure 3C-2 (P.C.B. No. 1) General View (Top)

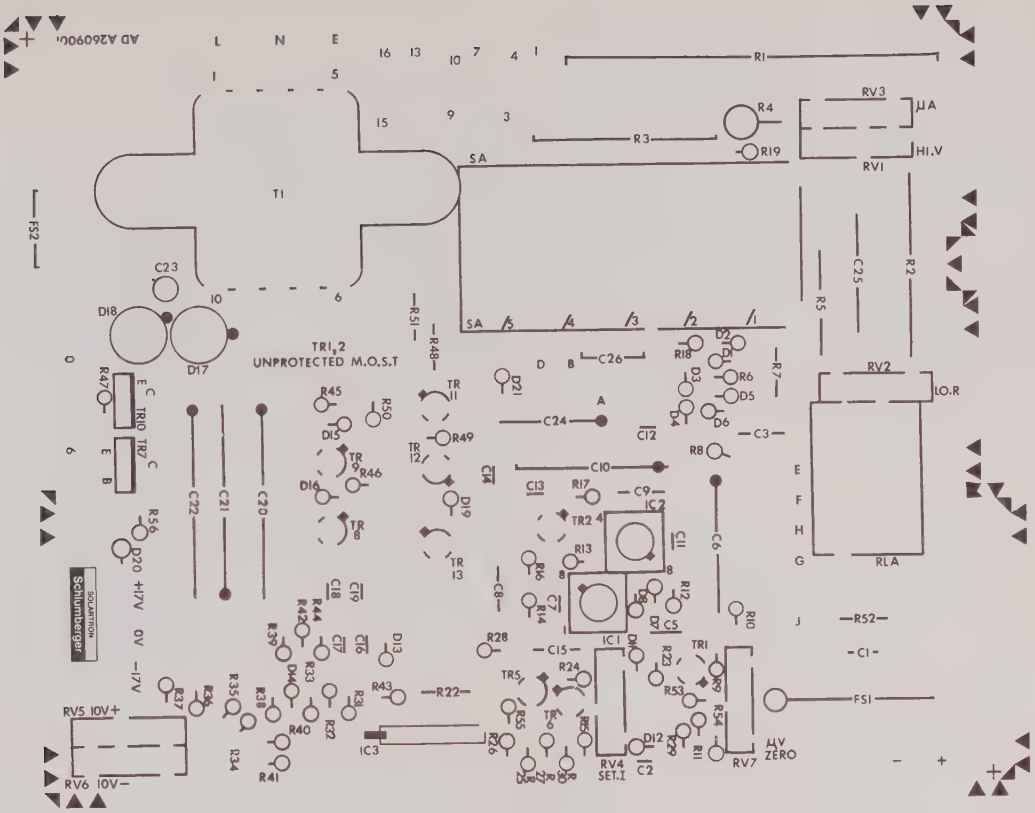


Figure 3C-3 (P.C.B. No. 1) Component Notation

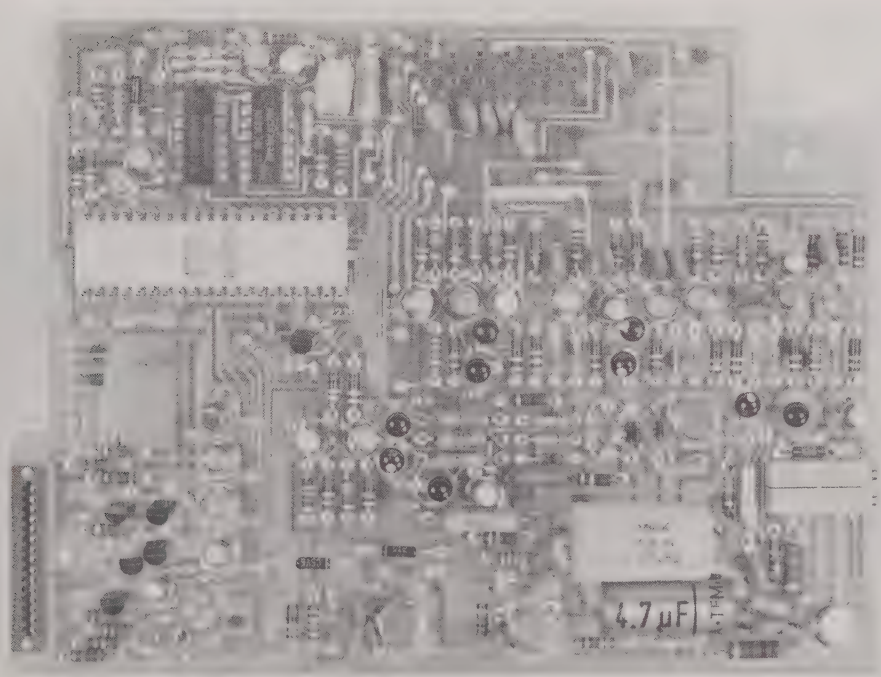


Figure 3C-4 (P.C.B. No. 2) General View (Top)

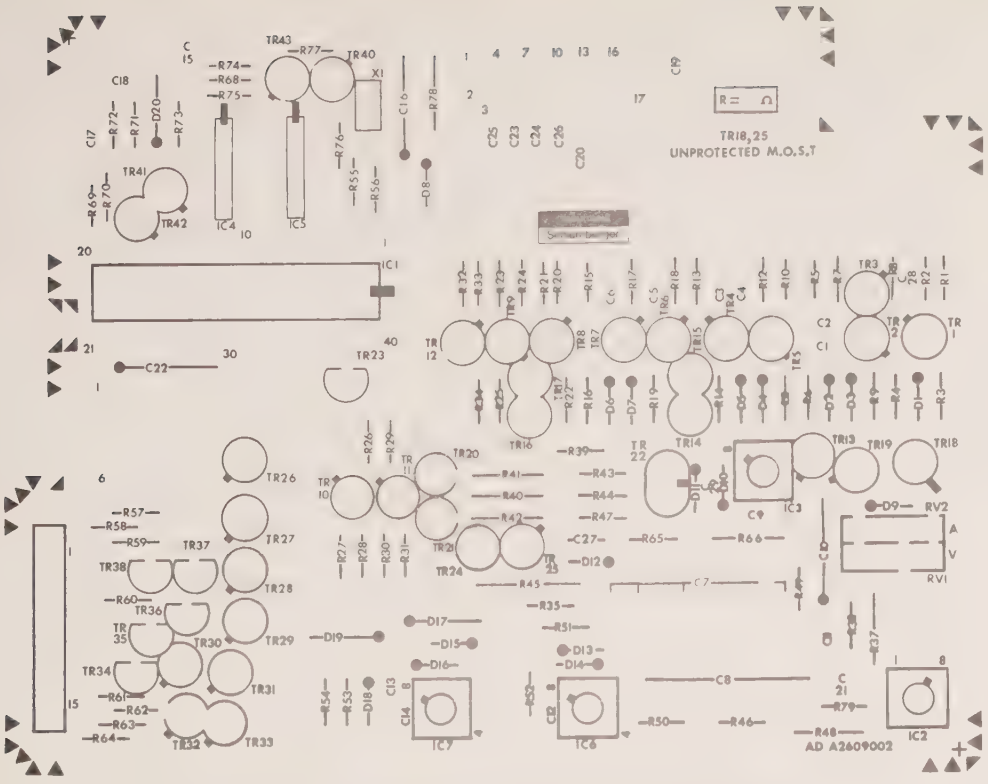


Figure 3C-5 (P.C.B. No. 2) Component Notation

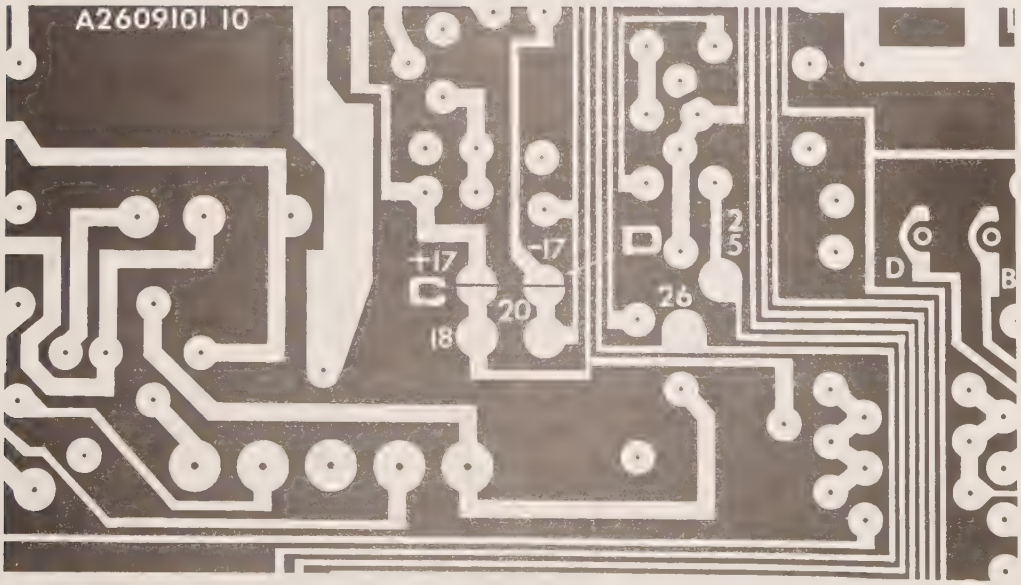


Figure 3C-6 (P.C.B. No. 1) Solder Pad Links 'C' and 'D'

±17V STABILISED SUPPLY

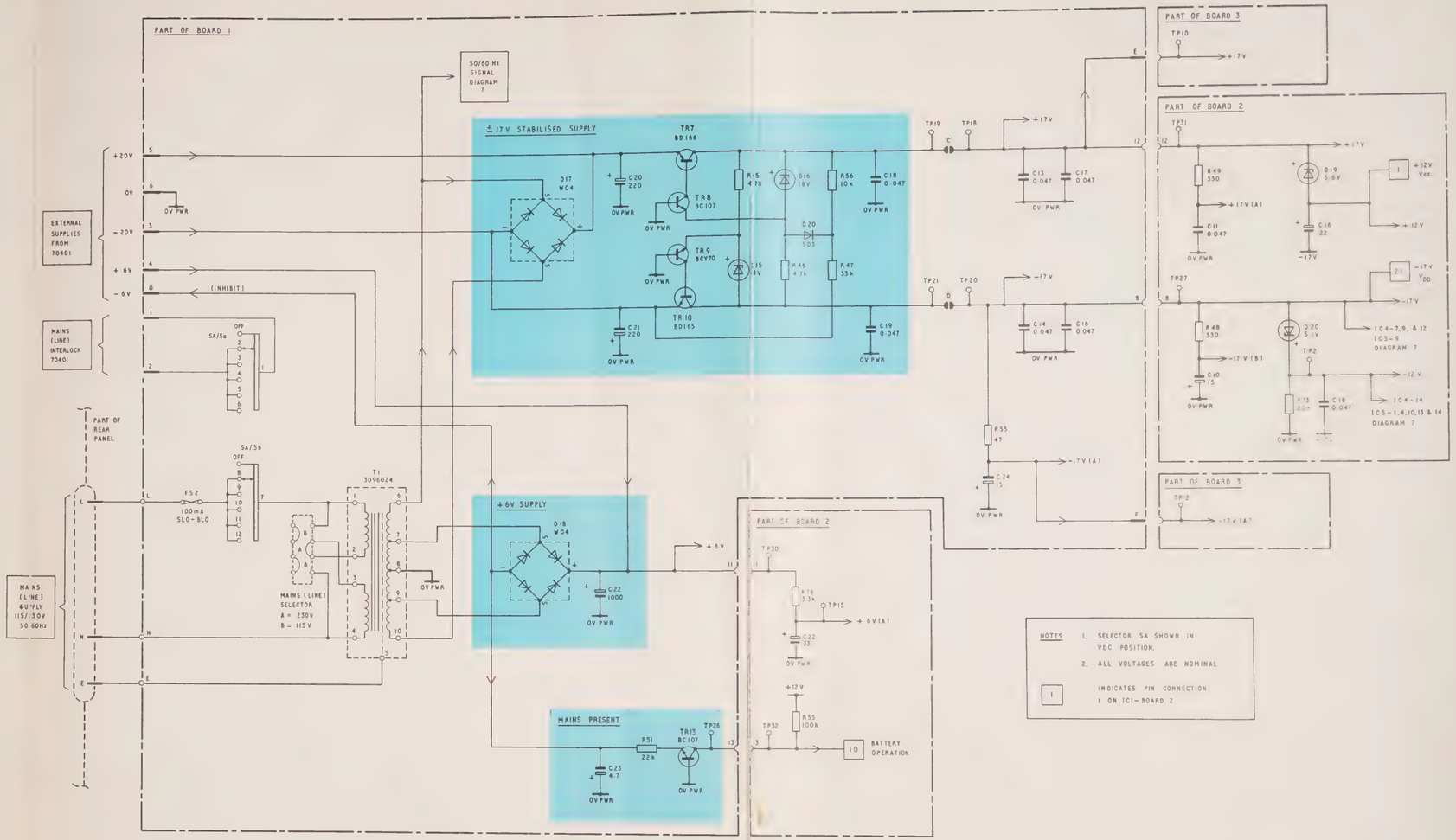
A full-wave stabilised supply used to generate all the internal dc supplies for use within the instrument except for the LED display. R47/R56/D20 provide a bleed current to insure that both rails switch-on when energised.

+6V SUPPLY

A full-wave rectified supply used to provide power for the LED display. The -6V output inhibits the external battery option type 70401 when mains supplies are in use.

MAINS PRESENT

Whenever -6V is available signifying that the instrument is operating from mains supplies, IC1-pin 10 is driven high. When operation from a battery unit is in progress, the input is driven low and IC1 (MOS-LS1 circuit) internally generates its own cycle reference timing pulses which would normally be synchronised to the mains frequency via the SHAPER (DIAGRAM 7).



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POWER SUPPLIES (CIRCUIT DIAGRAM)

SECTION 4 Setting–Up Procedures

This section contains suitable setting-up procedures for checking out sections of the instrument. Reference should be made to SECTION 5 - CALIBRATION for detailed calibration procedures.

INTRODUCTION

The following setting-up procedure when carried out completely will provide a DMM which will function correctly but will not necessarily comply in all respects with the published specification detailed in SECTION 7 - SPECIFICATIONS of this manual.

The information in this section has been provided to enable the user to select the appropriate procedures dealing with specific functional areas of the instrument.

In cases where the instrument is known to function correctly but is in need of final calibration, reference should be made to SECTION 5 - CALIBRATION for detailed calibration procedures.

TEST EQUIPMENT

The following special test equipment should be available to perform the following procedures correctly.

(a) TEST BOX (refer to APPENDIX for specific details).

(b) TEST CONNECTOR (Part No. Ex 70409).

(c) DUMMY CALIBRATION CASE (Part No. 4696004).

PRELIMINARY PROCEDURE

(a) Assemble the instrument as detailed in SECTION 3 up until the stage shown in Figure 4-1.

(b) Connect the two assemblies together using the Test Connector.

(c) Ensure that the equipment is arranged correctly for use on the local supply - refer to SECTION 2 - OPERATION for specific details.

(d) Select 'VDC' on mode selector.

(e) Allow equipment to warm-up for one hour.

(f) Switch Test Connector switch to position 3 (pin 1 of board 2 shorted to 0V rail).

(g) Monitor TP6 (Bd 2) with a DVM and adjust RV1 (bd 2) for a DVM reading < 0.03 mV.

(h) Select position 2 on Test Connector (pin 1 of board 2 connected to 0V rail via 270KΩ//0.1μF).

(j) Adjust RV2 (Bd 2) for a reading > ± 0.02mV on the LED display.

(k) Switch off power.

(l) Assemble the instrument as usual but employing the Dummy Calibration Case in place of the normal case.

(m) Now carry out the required calibration procedures selected appropriately from the following list. If there is any doubt as to which procedures should be carried out, it is strongly recommended that all should be done.

ZERO PERFORMANCE

RANGING

DISPLAY CHECK

COMMON AND SERIES MODE

INPUT IMPEDANCE

AC SCALING

(n) Whenever any of the above checks are carried out, the instrument should be recalibrated as detailed in SECTION 5 - CALIBRATION.

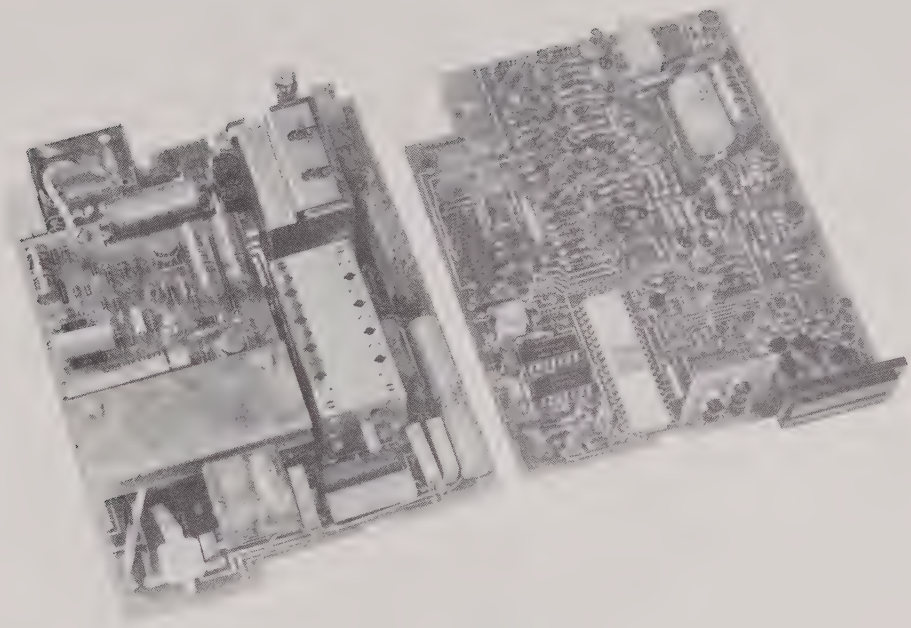


Figure 4-1 Preliminary Setting-up Arrangement

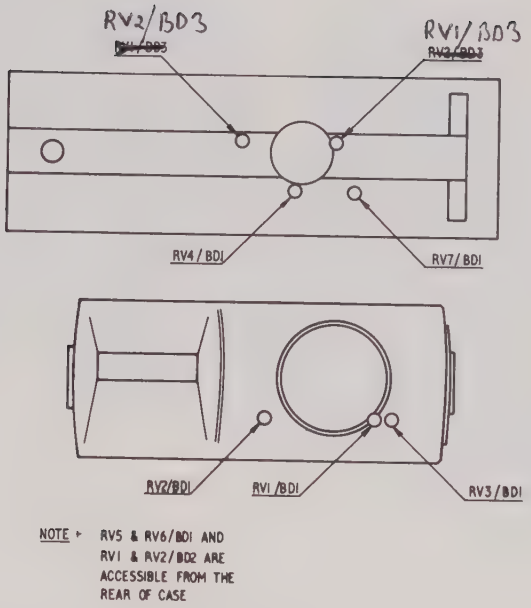


Figure 4-2 Dummy Calibration Case

ZERO PERFORMANCE

(a) Select 'VDC' on mode selector.

(b) Fit test box to input terminals.

(c) Select 'RC' on test box (IMΩ//1μF across input terminals).

(d) Adjust RV4 (Bd 1) for ± 0.00mV.

(e) Select 'SC' (direct short-circuit across input terminals).

(f) Adjust RV7 (Bd 1) for ± 0.00mV.

(g) Reselect 'RC' and if necessary, re-adjust RV4 (Bd 1) for ± 0.00mV.

(h) Reselect 'SC' and check that reading is still ± 0.00mV.

(j) Leave the test box in 'SC' position.

(k) Select 'VAC' on mode selector and check that reading is ⩾ 0.09mV.

(l) Adjust RV2 (Bd 2) for ⩾ 0.04 mV.

(m) Select 'Ω' on mode selector and check that reading does not exceed 0.2Ω.

(n) Select 'OC' on test box (input terminals open-circuit).

(p) Select 'μA' on mode selector and check that the reading does not exceed ± 0.001μA.

(q) Remove test equipment.

RANGING

(a) Select 'VDC' on mode selector.

(b) Apply + 10.000V to the input terminals.

(c) Adjust RV5 (Bd 1) for 10.000V.

(d) Reverse the input leads.

(e) Adjust RV6 (Bd 1) for -10.000V.

(f) Reverse the input leads back to the normal position.

(g) Reduce the input to + 1.0000V and check that the reading is 1.0000V ± 1 digit.

(h) Reverse the input leads.

(j) Check that reading is -1.0000V ± 1 digit.

(k) Reverse the input leads back to the normal position.

(l) Reduce the input to + 0.10mV.

(m) By reversing the polarity of the input (reversing the input leads) adjust RV7 (Bd 1) for equal readings positive and negative, split any deviations between readings.

(n) Increase input to +100.00mV.

(p) Check that reading is 100.00mV ± 2 digits.

(q) Reverse input (as in step (m) above) and check that reading is -100.00 mV ± 2 digits.

(r) Remove voltage source.

(s) Select 'Ω' on mode selector.

(t) Connect a known standard resistance of 100.00K Ω to the input.

(u) Adjust RV2 (Bd 1) for 100.00KΩ.

(v) Remove resistance.

(w) Select 'VDC' on mode selector.

(x) Apply 100.00V to input terminals.

(y) Adjust RV1 (Bd 1) for 100.00V.

(z) Increase input to 1000.0V and check that the reading is 1000.0V ± 0.2V.

(aa) Remove voltage source.

DISPLAY CHECK

(a) Select 'VDC' on mode selector.

(b) Fit the test box to input terminals.

(c) Select 'SC' on test box.

(d) Check that the 'mV' annunciator lights.

(e) Select 'Ω' on mode selector.

(f) Check that 'Ω' annunciator lights.

(g) Select 'OC' on test box.

(h) Check that the 'KΩ' annunciator lights and that overload is indicated i.e. display blank except for most significant digit.

(j) Select 'μA' on mode selector.

(k) Check that the 'μA' annunciator lights.

(l) Select 'DC' on test box (adjustable 3V dc source across input terminals).

(m) Check that overload is indicated by a blanked display with most significant digit flashing at about 3Hz.

(n) Select 'VDC' on mode selector.

(p) Check that the 'V' annunciator lights when the applied input voltage is >0.2V.

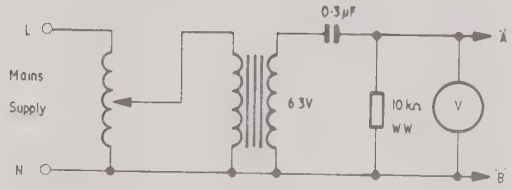
(q) Vary the applied voltage and check that all bars of the display are operating, and are well matched.

COMMON AND SERIES MODE

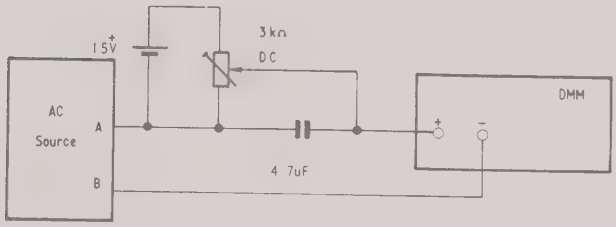
AC Series Mode

(a) Select 'VDC' on the mode selector.

(b) Connect up the following circuit. (The AC source introduces a 90^{o} phase shift).



TYPICAL AC SOURCE



(c) Set the DC potentiometer for approximately 500 mV with no ac input.

(d) Record the displayed reading.

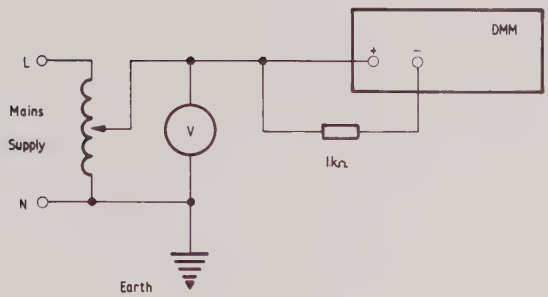
(e) Adjust the variac for 1V rms on meter.

(f) Check that display reading change does not exceed 0.5mV.

AC Common Mode

(a) Select 'VAC' on the mode selector.

(b) Connect up the following circuit.



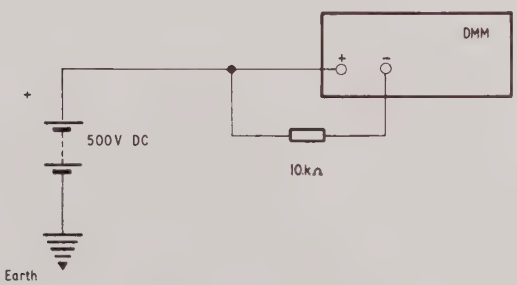
(c) Adjust the variac output to 100V rms.

(d) Check that the display reading does not exceed 25 mV.

DC Common Mode

(a) Select 'VAC' on the mode selector.

(b) Connect up the following circuit.

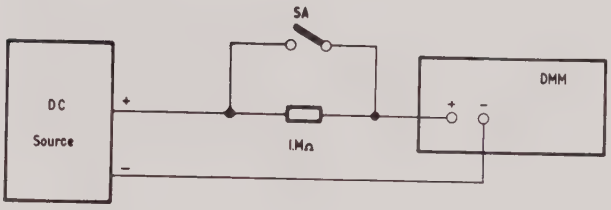


(c) With 500V dc applied, check that the displayed reading does not exceed 0.50 mV.

INPUT IMPEDANCE

(a) Select 'VDC' on mode selector.

(b) Connect up the following circuit.



(c) With switch closed, adjust dc source for reading of 10.000V.

(d) Open switch, reading should not exceed 10.000V ± 10 digits.

(e) Repeat with reversed polarity. Reading should be -10.000V ± 10 digits.

AC SCALING

(a) Select 'VAC' on mode selector.

(b) Apply 1.0000V @ 1KHz to input terminals.

(c) Adjust RV2 (Bd 3) for 1.0000V ± 1 digit.

(d) Increase input to 100.00V @ 1KHz.

(e) Adjust RV1 (Bd 3) for 100.00V ± 1 digit.

(f) Remove voltage source.

SECTION 5 Calibration

This section contains full calibration procedures for the instrument.

INTRODUCTION

The following calibration is basically the final calibration procedure to which all instruments are subjected to prior to despatch from the factory.

The setting-up procedure detailed in SECTION 4 when completed correctly will provide a DMM which will function correctly but will not always comply in all respects with the published specifications.

The correct completion of the following calibration procedure will ensure that the suspect DMM is functioning within specification.

For convenience, the calibration procedure has been printed on transparent sheets suitable for reproduction enabling the user to record results obtained with individual instruments.

TEST EQUIPMENT

The following items of test equipment should be available to perform the whole of the following procedure:-

(a) DC Voltage Standard (e.g. COHU Model 351).

(b) Decade Voltage Divider (e.g. E.S.I. Model RV622A).

(c) AC Voltage Standard (e.g. H.P. Model 745A complete with Model 746A).

(d) Decade Resistance Standard (e.g. E.S.I. Model RS624)

(e) 5.000 M Resistance Standard.

(f) 10.000 M Resistance Standard.

Additional Notes

(a) For DC voltages <1V, use items (a) and (b) together to form a potential divider.

(b) Use items (a) and (d) to provide a constant current source. Monitor voltage drop across item (d) with a DVM. Adjust current limit control to minimum to keep within the wattage limitation of item (d) above.

CALIBRATION

The calibration test sequence consists of the following steps, normally carried out on automatic test equipment. Calibration should be carried out at 23°C ±1°C ambient temperature after a minimum of one hour warm-up period in the dummy case which is provided with suitable access holes for preset potentiometers.

Standard Settings

During the above warm-up period, the DMM should be set to the following standard condition:

(a) Input Supply: 240V 50Hz

(b) Mode Selector: VDC

(c) Input Terminals: Short-circuit.

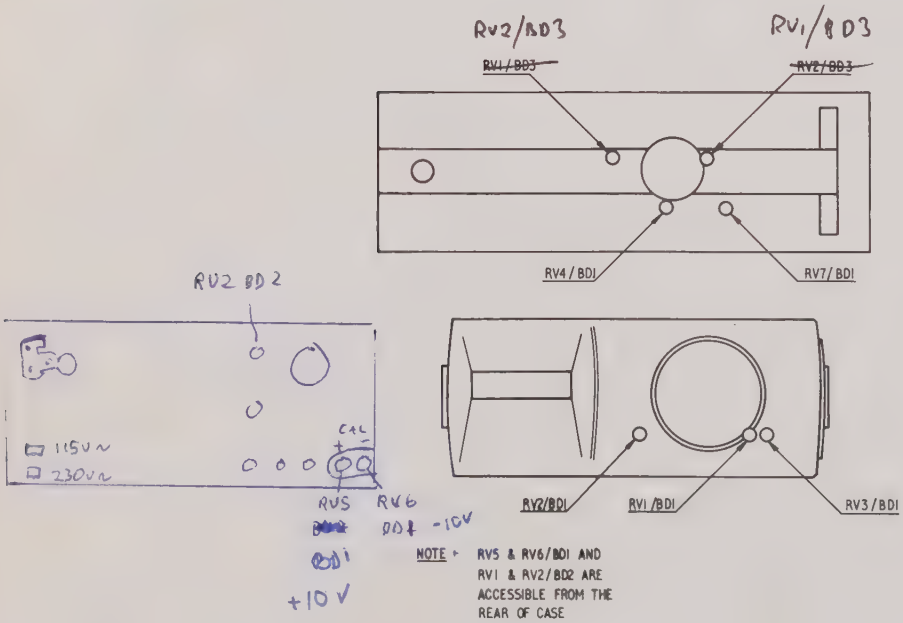


Figure 5-1 Dummy Calibration Case

CALIBRATION PROCEDURE 1

Select 'VDC' on Mode Selector.

STEP	INPUT	OPERATION	DISPLAY	RESULT
1	1MΩ /1μF	ADJ Bd.1/RV4	± 0.00mV ± 1	
2	S/C	ADJ Bd.1/RV7	± 0.00mV	
3	1MΩ/1μF	ADJ Bd.1/RV4	± 0.00mV ± 1	
4a 4b	0.10mV -0.10mV	(1) ADJ Bd.1/RV7	± 0.10mV ± 2	
5	10.000V	ADJ Bd.1/RV5	10.000V ± 1	
6	-10.000V	ADJ Bd.1/RV6	-10.000V ± 1	
7	10.000V with 1MΩ in series	Check	10.000V ± 10	

Notes

(1) Adjust for equal reading, split any deviations between readings.

CALIBRATION PROCEDURE 2

Select 'Ω' on Mode Selector.

STEP	INPUT	OPERATION	DISPLAY	RESULT
1	105.00k	ADJ Bd.1/RV2	105.00k ± 1	
2	50.00k	Check	50.00k ± 1	
3	10.500k	Check	(1) 10.50k ± 1½	
4	<5k	(2) Range Change	-	
5	10.500k	Check	10.500k ± 3	
6	5.00k	Check	4.000k ± 2	
7	1.0500k	Check	(1) 1.050k ± 1½	

8	<1k	(2) Range Change	-	
9	1.0500k	Check	1.0500k ± 5	
10	500.0	Check	500.0 ± 4	
11	100.0	Check	100.0 ±3	
12	(3) S/C	Check	0.0 ± 2	
13	>500k	(2) Range Change	-	
14	1.0500M	ADJ Bd.1/RV2	1050.0k ± 1	
15	500.0k	Check	500.0k ± 2	
16	105.00k	Check	105.0k ± $1\frac{1}{2}$	
17	<100k	(2) Range Change	-	
18	O/C	Check	(4) 1----k	
19	10.000M	Check	10000k ± 10	
20	5.000M	Check	5000k ± 5	

Notes

(1) A tolerance reading of $\pm 1\frac{1}{2}$ signifies a last digit 'flicker'.

(2) Check that a ranging operation occurs usually by a shift in decimal point position.

(3) A direct short-circuit should be used between the input terminals.

(4) Ensure that the indicated positions are blank and that the '1' does not flash.

CALIBRATION PROCEDURE 3

Select 'VDC' on Mode Selector.

STEP	INPUT	OPERATION	DISPLAY	RESULT
1	+10.000V	Recheck	10.000V ±1	
2	+1.050V	Check	1.050V ±1	
3	0.5V	(1) Range Change	-	
4	+1.050V	Check	1.0500V ±2	
5	+105.0mV	Check	105.0mV ±1	
6	50mV	(1) Range Change	-	
7	+105.00mV	Check	105.00mV ±3	
8	+10.00mV	Check	10.00mV ±2	
9	-10.000V	Recheck	-10.000V ±1	
10	-1.050V	Check	-1.050V ±1	
11	-0.5V	(1) Range Change	-	
12	-1.0500V	Check	-1.0500V ±2	
13	-105.0mV	Check	-105.0mV ±1	
14	-50mV	(1) Range Change	-	
15	-105.00mV	Check	-105.00mV ±3	
16	-10.00mV	Check	-10.00mV ±2	
17	+105.00V	Check	(2) 105.0V ±1½	
18	+1000V	Check	(3) 1000V ±3	
19	-1000V	Check.	-1000V ±3	
20	-105.00V	Check	(2) -105.0V ±1½	

Notes

(1) Check that a ranging operation occurs, usually by a shift in decimal point position.

(2) A tolerance reading of ±1½ signifies a last digit 'flicker'.

(3) Wait at least 5 seconds before recording reading.

CALIBRATION PROCEDURE 4

Select 'μA' on Mode Selector.

STEP	INPUT	OPERATION	DISPLAY	RESULT
1	O/C	Check	0.000μA ±2	
2	1.0000mA	ADJ Bd.1/RV3	1000.0μA ± 1	
3	<90μA	(1) Range Change	-	
4	+100.00μA	Check	100.00μA ±3	
5	<9μA	(1) Range Change	-	
6	+10.00μA	Check	10.000μA ±4	
7	+1.000μA	Check	1.000μA ±3	
8	-20V	Check	(2) -1----μA	
9	-1.0000mA	Check	-1000.0μA ±3	
10	<-90μA	(1) Range Change	-	
11	-100.00μA	Check	-100.00μA ±3	
12	<-9μA	(1) Range Change	-	
13	-10.000μA	Check	-10.000μA ±4	
14	-1.000μA	Check	-1.000μA ±3	
Now Select 'RF Probe' on Mode Selector.				
15	+100.00μA	Check	(3) 1.0000V ±3	
16	+20V	Check	(2) 1---V	

Notes

(1) Check that a ranging operation occurs, usually by a shift in decimal point position.

(2) Ensure that indicated positions are blank and that '1' is flashing.

(3) Check that the annunciator units display is correct.

CALIBRATION PROCEDURE 5

Select 'VAC' on Mode Selector.

STEP	INPUT	FREQ	OPERATION	DISPLAY	RESULT
1	(1) S/C	-	Check	0.00mV±6	
2	1.0000V	1kHz	ADJ Bd.3/RV2	1.0000V±1	
3	1.00mV	1kHz	ADJ Bd.2/RV2	0.97mV±1	
4	100mV	1kHz	Check	100.00mV±5	
5	1.0000V	30Hz	Check	1.0000V±20	
6	<50mV	30Hz	(2) Range Change	-	
7	100mV	30Hz	Check	100.00mV±20	
8	1.0000V	10kHz	Check	1.0000V±15	
9	1.0000V	20kHz	Check	1.0000V	
10	50mV	10kHz	(2) Range Change	-	
11	100mV	10kHz	Check	100.00mV±10	
12	10.00mV	10kHz	Check	10.00mV±10	
13	1.00mV	20kHz	Check		
14	100V	1kHz	ADJ Bd.3/RV1	100.00V±2	
15	1.200V	1kHz	Check	1.200V±5	
16	700V	1kHz	Check	700.0V±10	
17	100V	10kHz	Check	100.00V±20	
18	100V	20kHz	Check	100.00V	
19	700V	10kHz	Check	700.0V±20	

Notes

(1) A direct short-circuit should be used between the input terminals.

(2) Check that a ranging operation occurs, usually by a shift in decimal point position.

CALIBRATION PROCEDURE 1

Select 'VDC' on Mode Selector.

STEP	INPUT	OPERATION	DISPLAY	RESULT
1	1MΩ/1μF	ADJ Bd.1/RV4	± 0.00mV ± 1	
2	S/C	ADJ Bd.1/RV7	± 0.00mV	
3	1MΩ/1μF	ADJ Bd.1/RV4	± 0.00mV ± 1	
4a	0.10mV	(1)		
4b	-0.10mV	ADJ Bd.1/RV7	± 0.10mV ± 2	
5	10.000V	ADJ Bd.1/RV5	10.000V ± 1	
6	-10.000V	ADJ Bd.1/RV6	-10.000V ± 1	
7	10.000V with 1MΩ in series	Check	10.000V ± 10	

Notes

(1) Adjust for equal reading, split any deviations between readings.

CALIBRATION PROCEDURE 2

Select 'Ω' on Mode Selector.

STEP	INPUT	OPERATION	DISPLAY	RESULT
1	105.00k	ADJ Bd.1/RV2	105.00k ± 1	
2	50.00k	Check	50.00k ± 1	
3	10.500k	Check	(1) 10.50k ± 1½	
4	<5k	(2) Range Change	-	
5	10.500k	Check	10.500k ± 3	
6	5.00k	Check	4.000k ± 2	
7	1.0500k	Check	(1) 1.050k ± 1½	

CALIBRATION PROCEDURE 1

Select 'VDC' on Mode Selector.

STEP	INPUT	OPERATION	DISPLAY	RESULT
1	1MΩ \ 1 µF	ADJ Bd.1/RV4	± 0.00mV ± 1	
2	S\C	ADJ Bd.1/RV7	± 0.00mV	
3	1MΩ\1µF	ADJ Bd.1/RV4	± 0.00mV ± 1	
4a 4b	0.10mV -0.10mV	(1) ADJ Bd.1/RV7	± 0.10mV ± 2	
5	10.000V	ADJ Bd.1/RV5	10.000V ± 1	
6	-10.000V	ADJ Bd.1/RV6	-10.000V ± 1	
7	10.000V with 1MΩ in series	Check	10.000V ± 10	

Notes

(1) Adjust for equal reading, split any deviations between readings.

CALIBRATION PROCEDURE 2

Select 'Ω' on Mode Selector.

STEP	INPUT	OPERATION	DISPLAY	RESULT
1	105.00k	ADJ Bd.1/RV2	105.00k ± 1	
2	50.00k	Check	50.00k ± 1	
3	10.500k	Check	(1) 10.50k ± 1⅔	
4	<5k	(2) Range Change	-	
5	10.500k	Check	10.500k ± 3	
6	5.00k	Check	4.000k ± 2	
7	1.0500k	Check	(1) 1.050k ± 1⅔	

Select 'VDC' on Mode Switch.

		(2) Range Change	
	1.0500k	Check	1.0500k ± 5
	500.0	Check	500.0 ± 4
	100.0	Check	100.0 ± 3
	(3) 0.0	Check	0.0 ± 2
	>500K	(2) Range Change	
14	1.0500M	ADJ Bd.1/RV2	1050.6k ± 1
15	500.0k	Check	500.0k ± 1
16	105.00k	Check	105.0k ± 1½
	100k	(2) Range Change	
18	0.0	Check	(4)
19	10.000M	Check	10000k ± 10
20	5.000M	Check	5000k ± 5

Notes

(1) A tolerance reading of ± 1½ signifies a last digit 'flicker'.

(2) Check that a ranging operation occurs usually by a shift in decimal point position.

(3) A direct short-circuit should be used between the input terminals.

(4) Ensure that the indicated positions are blank and that the '1' does not flash.

			105.0V ± 1½
			1000V ± 3
			(2) -105.0V ± 1½

Notes

(1) Check that a ranging operation occurs, usually by a shift in decimal point position.

(2) A tolerance reading of ± 1½ signifies a last digit 'flicker'.

CALIBRATION PROCEDURE 3

Select 'VDC' on Mode Selector.

STEP	INPUT	OPERATION	DISPLAY	RESULT
1	+10.000V	Recheck	10.000V ±1	
2	+1.050V	Check	1.050V ±1	
3	0.5V	(1) Range Change	-	
4	+1.050V	Check	1.0500V ±2	
5	+105.0mV	Check	105.0mV ±1	
6	50mV	(1) Range Change	-	
7	+105.00mV	Check	105.00mV ±3	
8	+10.00mV	Check	10.00mV ± 2	
9	-10.000V	Recheck	-10.000V ±1	
10	-1.050V	Check	-1.050V ± 1	
11	-0.5V	(1) Range Change	-	
12	-1.0500V	Check	-1.0500V ± 2	
13	-105.0mV	Check	-105.0mV ± 1	
14	-50mV	(1) Range Change	-	
15	-105.00mV	Check	-105.00mV ± 3	
16	-10.00mV	Check	-10.00mV ± 2	
17	+105.00V	Check	(2) 105.0V ± $1\frac{1}{2}$	
18	+1000V	Check	(3) 1000V ± 3	
19	-1000V	Check	-1000V ± 3	
20	-105.00V	Check	(2) -105.0V ± $1\frac{1}{2}$	

Notes

(1) Check that a ranging operation occurs, usually by a shift in decimal point position.

(2) A tolerance reading of ± $1\frac{1}{2}$ signifies a last digit 'flicker'.

(3) Wait at least 5 seconds before recording reading.

CALIBRATION PROCEDURE 3

Select 'VDC' on Mode Selector.

STEP	INPUT	OPERATION	DISPLAY	RESULT
1	+10.000V	Recheck	10.000V ± 1	
2	+1.050V	Check	1.050V ± 1	
3	0.5V	(1) Range Change	-	
4	+1.050V	Check	1.0500V ± 2	
5	+105.0mV	Check	105.0mV ± 1	
6	50mV	(1) Range Change	-	
7	+105.00mV	Check	105.00mV ± 3	
8	+10.00mV	Check	10.00mV ± 2	
9	-10.000V	Recheck	-10.000V ± 1	
10	-1.050V	Check	-1.050V ± 1	
11	-0.5V	(1) Range Change	-	
12	-1.0500V	Check	-1.0500V ± 2	
13	-105.0mV	Check	-105.0mV ± 1	
14	-50mV	(1) Range Change	-	
15	-105.00mV	Check	-105.00mV ± 3	
16	-10.00mV	Check	-10.00mV ± 2	
17	+105.00V	Check	(2) 105.0V ± 1½	
18	+1000V	Check	(3) 1000V ± 3	
19	-1000V	Check	-1000V ± 3	
20	-105.00V	Check	(2) -105.0V ± 1½	

Notes

(1) Check that a ranging operation occurs, usually by a shift in decimal point position.

(2) A tolerance reading of ± 1½ signifies a last digit 'flicker'.

(3) Wait at least 5 seconds before recording reading.

CALIBRATION PROCEDURE 4

Select 'μA' on Mode Selector.

STEP	INPUT	OPERATION	DISPLAY	RESULT
1	O/C	Check	0.000μA ±2	
2	1.0000mA	ADJ Bd.1/RV3	1000.0μA ± 1	
3	<90μA	(1) Range Change	-	
4	+100.00μA	Check	100.00μA ±3	
5	<9μA	(1) Range Change	-	
6	+10.00μA	Check	10.000μA ±4	
7	+1.000μA	Check	1.000μA ±3	
8	-20V	Check	(2) -1----μA	
9	-1.0000mA	Check	-1000.0μA ±3	
10	<-90μA	(1) Range Change	-	
11	-100.00μA	Check	-100.00μA ±3	
12	<-9μA	(1) Range Change	-	
13	-10.000μA	Check	-10.000μA ±4	
14	-1.000μA	Check	-1.000μA ±3	
Now Select 'RF Probe' on Mode Selector.				
15	+100.00μA	Check	(3) 1.0000V ±3	
16	+20V	Check	(2) 1---V	

Notes

(1) Check that a ranging operation occurs, usually by a shift in decimal point position.

(2) Ensure that indicated positions are blank and that '1' is flashing.

(3) Check that the annunciator units display is correct.

CALIBRATION PROCEDURE 4

Select 'μA' on Mode Selector.

STEP	INPUT	OPERATION	DISPLAY	RESULT
1	O/C	Check	0.000μA ±2	
2	1.0000mA	ADJ Bd.1/RV3	1000.0μA ± 1	
3	<90μA	(1) Range Change	-	
4	100.00μA	Check	100.00μA ±3	
5	<9μA	(1) Range Change	-	
6	+10.00μA	Check	10.000μA ±4	
7	+1.000μA	Check	1.000μA ±3	
8	-20V	Check	(2) -1----μA	
9	-1.0000mA	Check	-1000.0μA ±3	
10	<-90μA	(1) Range Change	-	
11	-100.00μA	Check	-100.00μA ±3	
12	<-9μA	(1) Range Change	-	
13	-10.000μA	Check	-10.000μA ±4	
14	-1.000μA	Check	-1.000μA ±3	
Now select 'RF Probe' on Mode Selector.				
15	+100.00μA	Check	(3) 1.0000A ±3	
16	+20V	Check	(2) 1---A	

Notes

(1) Check that a ranging operation occurs, usually by a shift in decimal point position.

(2) Ensure that indicated positions are blank and that '1' is flashing.

(3) Check that the annunciator units display is correct.

CALIBRATION PROCEDURE 5

Select 'VAC' on Mode Selector.

STEP	INPUT	FREQ	OPERATION	DISPLAY	RESULT
1	(1) S/C	-	Check	0.00mV±6	
2	1.0000V	1kHz	ADJ Bd.3/RV2	1.0000V±1	
3	1.00mV	1kHz	ADJ Bd.2/RV2	0.97mV±1	
4	100mV	1kHz	Check	100.00mV±5	
5	1.0000V	30Hz	Check	1.0000V±20	
6	<50mV	30Hz	(2) Range Change	-	
7	100mV	30Hz	Check	100.00mV±20	
8	1.0000V	10kHz	Check	1.0000V±15	
9	1.0000V	20kHz	Check	1.0000V	
10	50mV	10kHz	(2) Range Change	-	
11	100mV	10kHz	Check	100.00mV±10	
12	10.00mV	10kHz	Check	10.00mV±10	
13	1.00mV	20kHz	Check		
14	100V	1kHz	ADJ Bd.3/RV1	100.00V±2	
15	1.200V	1kHz	Check	1.200V±5	
16	700V	1kHz	Check	700.0V±10	
17	100V	10kHz	Check	100.00V±20	
18	100V	20kHz	Check	100.00V	
19	700V	10kHz	Check	700.0V±20	

Notes

(1) A direct short-circuit should be used between the input terminals.

(2) Check that a ranging operation occurs, usually by a shift in decimal point position.

Select 'VAC' on Mode Selector.

STEP	INPUT	FREQ	OPERATION	DISPLAY	RESULT
1	(1) S/C	-	Check	0.00mV±6	
2	1.0000V	1kHz	ADJ Bd.3/RV2	1.0000V±1	
3	1.00mV	1kHz	ADJ Bd.2/RV2	0.97mV±1	
4	100mV	1kHz	Check	100.00mV±5	
5	1.0000V	30Hz	Check	1.0000V±20	
6	<50mV	30Hz	(2) Range Change	-	
7	100mV	30Hz	Check	100.00mV±20	
8	1.0000V	10kHz	Check	1.0000V±15	
9	1.0000V	20kHz	Check	1.0000V	
10	50mV	10kHz	(2) Range Change	-	
11	100mV	10kHz	Check	100.00mV±10	
12	10.00mV	10kHz	Check	10.00mV±10	
13	1.00mV	20kHz	Check		
14	100V	1kHz	ADJ Bd.3/RV1	100.00V±2	
15	1.200V	1kHz	Check	1.200V±5	
16	700V	1kHz	Check	700.0V±10	
17	100V	10kHz	Check	100.00V±20	
18	100V	20kHz	Check	100.00V	
19	700V	10kHz	Check	700.0V±20	

Notes

(1) A direct short-circuit should be used between the input terminals.

(2) Check that a ranging operation occurs, usually by a shift in decimal point position.

SECTION 6 Parts Lists

This section contains detailed parts lists for each of the printed circuit boards fitted in the instrument. When ordering spare parts, it is essential to quote the instrument serial number located on the rear panel as well as the whole of the description shown in the appropriate parts list.

COMPONENT PARTS LIST

ABBREVIATIONS

Circuit References

B	Battery
C	Capacitor (μF)
CSR	Thyristor
D	Diode
FS	Fuse
IC	Integrated Circuit
L	Inductor
LP	Lamp (including Neon)
LK	Link
M	Meter
MSP	Mains Selector Panel
PL	Plug
R	Resistor (Ω)
RL	Relay
S	Switch
SK	Socket
T	Transformer
TP	Terminal Post (or Test Point)
TR	Transistor
V	Valve
X	Other Components

Also Used:-

RNL	Non Linear Resistor (Ω)
RV	Variable Resistor (Ω)

Component Composition

FIXED RESISTORS

Carbon Composition	CACP
Carbon Film	CAFM
Cracked Carbon	CKCA
Metal Film	MEFM
Metal Oxide	MEOX
Power Wirewound	POWW
Precision Wirewound	PRWW
Temperature Sensitive	TEMP
Thick Film	TKFM
Thin Film	TNFM
Voltage Sensitive	VOLT

Component Composition (Cont'd)

VARIABLE RESISTORS

Wirewound Preset Single Turn	WWPS
Wirewound Preset Multiturn	WWPM
Wirewound Front Panel Single Turn	WWFS
Wirewound Front Panel Multiturn	WWFM
Carbon Preset Single Turn	CAPS
Carbon Preset Multiturn	CAPM
Carbon Front Panel Single Turn	CAFS
Carbon Front Panel Multiturn	CAFM
Cermet Preset Single Turn	CMPS
Cermet Preset Multiturn	CMPM
Cermet Front Panel Single Turn	CMFS
Cermet Front Panel Multiturn	CMFM

CAPACITORS

Air	AIR
Aluminium Electrolytic	ALME
Aluminium Solid	ALMS
Polycarbonate	CARB
Ceramic	CERM
Polyester Foil	ESTF
Polyester Metallised	ESTM
Glass	GLAS
Mica	MICA
Metallised Lacquer	MLAC
Paper Foil	PAPF
Paper Metallised	PAPM
PTFE	PTFE
Polypropylene Film	PYLN
Polystyrene	STYR
Tantalum Dry	TAND
Tantalum Foil	TANF
Tantalum Wet	TANW

BOARD 1

Cct. Ref.	General Description	Value	V or W	%	Solartron Part No.
R1	MEFM	9.95M	2	.25	169603802
R2	MEFM	100.5k	1	.25	
R3	MEFM	100k	1	1	198751002
R4	CACP	470	1	10	172524700
R5	MEFM	9.9k	1/4	.2	160400363
R6	CACP	470	1/8	10	172024700
R7	CACP	1000	1/8	10	172031000
R8	CACP	47k	1/8	10	172044700
R9	CACP	47k	1/8	10	172044700
R10	CACP	220k	1/8	10	172052200
R11	CACP	220k	1/8	10	172052200
R12	CACP	22	1/8	10	172012200
R13	CACP	220k	1/8	10	172052200
R14	CACP	10k	1/8	10	172041000
R15	CACP	68k	1/8	10	172046800
R16	CACP	220k	1/8	10	172052200
R17	CACP	220k	1/8	10	172052200
R18	CACP	100	1/8	10	172021000
R19	CACP	100	1/8	10	172021000
R22	CACP	47k	1/8	10	172044700
R23	CACP	18k	1/8	10	172041800
R24	CACP	39k	1/8	10	172043900
R25	CACP	10k	1/8	10	172041000
R26	CACP	39k	1/8	10	172043900
R27	CACP	39k	1/8	10	172043900
R28	CACP	39k	1/8	10	172043900
R29	CACP	18k	1/8	10	172041800
R30	CACP	10k	1/8	10	172041000
R31	CACP	220k	1/8	10	172052200
R32	CACP	8200	1/8	10	172038200
R33	MEFM	1800		1	192731801
R34	MEFM	12k		.5	169607901
R35	MEFM	20.5k		.5	
R36	MEFM	1800		1	192731801
R37	MEFM	910		1	192729101
R38	MEFM	10k		.25	192841002

Cct. Ref.	General Description	Value	V or W	%	Solartron Part No.
R39	MEFM	101		.25	192821012
R40	MEFM	18k		.5	169607301
R41		18k		.5	
R42	MEFM	8200	1/8	10	172038200
R43	MEFM	10k		.2	192841002
R44	MEFM	101		.2	192821012
R45	CACP	4700	1/8	10	172034700
R46	CACP	4700	1/8	10	172034700
R47	CACP	33k	1/8	10	172043300
R48	CACP	22k	1/8	10	172042200
R49	CACP	100k	1/8	10	172051000
R50	CACP	68k	1/8	10	172046800
R51	CACP	22k	1/8	10	172042200
R52	CACP	1000	1/8	10	172031000
R53	CACP	1.5M	1/8	10	172061500
R54	CACP	10	1/8	10	172011000
R55	CACP	47	1/8	10	172014700
R56	CACP	10k	1/8	10	172041000
RV1	CMPM	100k		10	130651000
RV2	CMPM	1000		10	130631000
RV3	CMPM	200		10	130622000
RV4	CMPM	30k		10	130642000
RV5	CMPM	1000		10	130631000
RV6	CMPM	200		10	130622000
RV7	CMPM	1M		10	130661000
C1	CERM	470p	1500	20	208450090
C2	CERM	100p	500	20	241321000
C3	ESTM	.22	100	10	225452200
C5	ESTM	.047	100	10	225444700
C6	ALME	220	10	20	273182200
C7	ESTM	.22	100	10	225452200

Cct. Ref.	General Description	Value	V or W	%	Solartron Part No.
C9	ESTM	.22	100	10	225452200
C10	ESTM	.47	63	10	225154700
C11	TAND	47	20	20	265874700
C12	CERM	150p	500	20	241321500
C13	CERM	10p	500	20	241311000
C14	CERM	.047	25	+50 -25	241944700
C15	CERM	.047	25	+50 -25	241944700
C16	ESTM	.47	63	10	225154700
C17	CERM	.047	25	+50 -25	241944700
C18	CERM	.047	25	+50 -25	241944700
C19	CERM	.047	25	+50 -25	241944700
C20	ALME	220	40	20	273782200
C21	ALME	220	40	20	273782200
C22	ALME	1000	10	20	273191000
C23	TAND	4.7	10	20	265464700
C24	TAND	15	20	20	265871500
C25	ESTF	.22	400	20	226152200
C26	ESTF	4700p	400	10	227434700
D1	SD3				300522160
D2	SD3				300522160
D3	ZENER	12V	.4	5	300521480
D4	ZENER	12V	.4	5	300521480
D5	1N3595				300523590
D6	1N3595				300523590
D7	SD3				300522160
D8	SD3				300522160
D11	ZENER	3.9V	.4	5	300521420
D12	ZENER	3.9V	.4	5	300521420
D13	1N4577	6.4V			300525050
D14	SD3				300522160

Cct. Ref.	General Description	Value	V or W	%	Solartron Part No.
D15	ZENER	18V	.4	2	300525040
D16	ZENER	18V	.4	2	300525040
D17	W04				300524700
D18	W04				300524700
D19	SD3				300522160
D20	SD3				300522160
D21	SD3				300522160
TR1	40673				300555210
TR2	3N141				300554210
TR5	BC107				300553320
TR6	BC107				300553320
TR7	BD166				300555150
TR8	BC107				300553320
TR9	BCY70				300553590
TR10	BD165				300555160
TR11	BC107				300553320
TR12	BCY70				300553590
TR13	BC107				300553320
IC1	LM301AH				510000620
IC2	LM301AH				510000620
IC3	LM747CD				510090020
RLA	RELAY				301201502
FS1	FUSE	500mA			360190080
FS2	FUSE	100mA			360190120
SA	SWITCH				379605003
T1	TRANSFORMER				309602404

BOARD 2

Cct. Ref.	General Description	Value	V or W	%	Solartron Part No.
R1	CACP	100k	1/8	10	172051000
R2	CACP	4700	1/8	10	172034700
R3	CACP	100k	1/8	10	172051000
R4	CACP	33k	1/8	10	172043300
R5	CACP	22k	1/8	10	172042200
R6	CACP	100k	1/8	10	172051000
R7	CACP	4700	1/8	10	172034700
R8	CACP	10k	1/8	10	172041000
R9	CACP	100k	1/8	10	172051000
R10	CACP	39k	1/8	10	172043900
R11	CACP	100k	1/8	10	172051000
R12	CACP	4700	1/8	10	172034700
R13	CACP	10k	1/8	10	172041000
R14	CACP	100k	1/8	10	172051000
R15	CACP	22k	1/8	10	172042200
R16	CACP	100k	1/8	10	172051000
R17	CACP	4700	1/8	10	172034700
R18	CACP	10k	1/8	10	172041000
R19	CACP	100k	1/8	10	172051000
R20	CACP	100k	1/8	10	172051000
R21	CACP	4700	1/8	10	172034700
R22	CACP	100k	1/8	10	172051000
R23	CACP	100k	1/8	10	172051000
R24	CACP	4700	1/8	10	172034700
R25	CACP	100k	1/8	10	172051000
R26	CACP	100k	1/8	10	172051000
R27	CACP	4700	1/8	10	172034700
R28	CACP	100k	1/8	10	172051000
R29	CACP	100k	1/8	10	172051000
R30	CACP	4700	1/8	10	172034700
R31	CACP	100k	1/8	10	172051000
R32	CACP	100k	1/8	10	172051000
R33	CACP	4700	1/8	10	172034700
R34	CACP	33k	1/8	10	172043300
R35	CACP	100k	1/8	10	172051000

Cct. Ref.		General Description Value	V or W	%	Solarton Part No.
R37	CACP	22M	1/4	10	172372200
R38	CACP	27k	1/8	10	172042700
R39	CACP	100	1/8	10	172021000
R40	MEFM	1M	1/8	1	191261002
R41	MEFM	100k	1/8	1	191251002
R42	MEFM	10k	1/8	1	1912410
R43	MEOX	18k	1/4	5	195641800
R44	MEOX	18k	1/4	5	195641800
R45	MEFM	990k	1/4	0.25	160400488
R46	MEOX	22k	1/4	5	195642200
R47	CACP	1M	1/8	10	172061000
R48	CACP	100	1/4	10	172321000
R49	CACP	330	1/8	10	172023300
R50	CACP	4700	1/8	10	172034700
R51	CACP	470k	1/8	10	172054700
R52	CACP	1000	1/8	10	172031000
R53	CACP	33k	1/8	10	172043300
R54	CACP	100k	1/8	10	172051000
R55	CACP	100k	1/8	10	172051000
R56	CACP	33k	1/8	10	172043300
R57	CACP	150	1/8	10	172021500
R58	CACP	150	1/8	10	172021500
R59	CACP	150	1/8	10	172021500
R60	CACP	150	1/8	10	172021500
R61	CACP	150	1/8	10	172021500
R62	CACP	150	1/8	10	172021500
R63	CACP	150	1/8	10	172021500
R64	CACP	150	1/8	10	172021500
R65	CACP	100k	1/8	10	172051000
R66	MEOX	680k	1/4	5	195456800
R68	MEOX	33k	1/4	5	195643300
R69	CACP	10k	1/8	10	172041000
R70	CACP	10k	1/8	10	172041000
R71	CACP	47k	1/8	10	172044700
R72	CACP	47k	1/8	10	172044700

Cct. Ref.	General Description	Value	V or W	%	Solartron Part No.
R73	CACP	2200	1/8	10	172032200
R74	MEOX	10k	1/4	5	195641000
R75	MEOX	4700	1/4	5	195634700
R76	MEOX	390	1/4	5	195623900
R77	CACP	2200	1/8	10	172032200
R78	CACP	2.2	1/2	10	172302200
R79	CACP	2200	1/8	10	172032200
RV1	CMPM	1000	3/4	10	130631000
RV2	CMPM	20k	3/4	10	130642000
C1	CERM	33p	500	20	241313300
C2	CERM	33p	500	20	241313300
C3	CERM	33p	500	20	241313300
C4	CERM	33p	500	20	241313300
C5	CERM	33p	500	20	241313300
C6	CERM	33p	500	20	241313300
C7	STYR	.1	63	1	208100180
C8	ESTM	4.7	63	10	219964700
C9	CERM	150p	500	20	241321500
C10	TAND	15	20	20	265871500
C11	CERM	.047	25	+50 -25	241944700
C12	CERM	150p	500	20	241321500
C13	CERM	10p	500	20	241311000
C14	CERM	150p	500	20	241321500
C15	CERM	10p	500	20	241311000
C16	TAND	22	35	20	266072200
C17	CERM	330p	500	20	241323300
C18	CERM	.047	25	+50 -25	241944700
C19	CERM	.047	25	+50 -25	241944700
C20	CERM	.047	25	+50 -25	241944700
C21	CERM	150p	500	20	241321500
C22	TAND	33	10	20	265473300
C23	CERM	1000p	500	20	241331000
C24	CERM	1000p	500	20	241331000

Cct. Ref.	General Description				Solartron Part No.
		Value	V or W	%	
C25	CERM	1000p	500	20	241331000
C26	CERM	1000p	500	20	241331000
C27	ESTM	.022	100	10	225442200
C28	CERM	47p	500	10	241314700
C29	CERM	150p	500	10	241321500
D1	SD3				300522160
D2	SD3				300522160
D3	SD3				300522160
D4	SD3				300522160
D5	SD3				300522160
D6	SD3				300522160
D7	SD3				300522160
D8	SD3				300522160
D9	0A47				300520850
D10	SD3				300522160
D11	SD3				300522160
D12	SD3				300522160
D13	SD3				300522160
D14	SD3				300522160
D15	SD3				300522160
D16	SD3				300522160
D17	ZENER	12V	.4	5	300521480
D18	SD3				300522160
D19	ZENER	5.6V	.4	5	300521450
D20	ZENER	5.1V	.4	5	300521310
TR1	BC108				300553320
TR2	BCY70				300553590
TR3	BC107				300553320
TR4	BCY70				300553590
TR5	BC107				300553320
TR6	BCY70				300553590
TR7	BC107				300553320
TR8	BC107				300553320
TR9	BC107				300553320
TR10	BC107				300553320
TR11	BC107				300553320
TR12	BC107				300553320

Cct. Ref.	General Description	Value	V or W	%	Solartron Part No.
TR13	Selected SET of 4 F.E.T. with TR21	REFER TO APPENDIX			300554320
TR14					300554320
TR15					300554320
TR16	U1899E				300554320
TR17	U1899E				300554320
TR18	3N163				300554530
TR19	2N4303				300553160
TR20	U1899E				300554320
TR21	U1899E Selected				300554320
TR22	WDZ11				300555060
TR23	MPS A13				300554560
TR24	2N4303				300553160
TR25	3N163				300554530
TR26	BC107				300553320
TR27	BC107				300553320
TR28	BC107				300553320
TR29	BC107				300553320
TR30	BC107				300553320
TR31	BC107				300553320
TR32	BC107				300553320
TR33	BC107				300553320
TR34	MPS A13				300554560
TR35	MPS A13				300554560
TR36	MPS A13				300554560
TR37	MPS A13				300554560
TR38	MPS A13				300554560
TR40	BC107				300553320
TR41	BC107				300553320
TR42	BC107				300553320
TR43	BCY70				300553590

Cct. Ref.	General Description Value	V or W	%	Solartron Part No.
IC1	MOS LOGIC			519600303
IC2	LM310H			510090040
IC3	LM301AH			510000620
IC4	SN74L00			510001030
IC5	SN74L74			510001110
IC6	LM301AH			510000620
IC7	LM301AH			510000620
X1	XTL			301900101
LED	DISPLAY (4 DIGIT)			309400201

BOARD 3

Cct. Ref.		General Description Value	V or W	%	Solartron Part No.
R1	MEFM	990k	2	.5	169606201
R2		9900	.5	.5	
R3	CACP	1M	1	10	172561000
R5	CACP	100k	1	10	172551000
R6	MEFM	16k	1/4	.5	169606101
R7		16.9k	1/4	.5	
R8	CACP	15k	1/8	10	172041500
R9	MEFM	27k	1/8	1	191242702
R10	CACP	18k	1/8	10	172041800
R11	CACP	18k	1/8	10	172041800
R12	MEFM	5100	1/16	1	192635102
R13	MEFM	5100	1/16	1	192635102
R14	CACP	1000	1/8	10	172031000
R15	CACP	27k	1/8	10	172042700
R16	MEOX	470	1/4	5	195624700
R17	MEOX	220	1/4	5	195622200
R18	CACP	100k	1/8	10	172051000
R19	CACP	100k	1/8	10	172051000
R20	CACP	2200	1/8	10	172032200
R21	CACP	2200	1/8	10	172032200
R22	CACP	10k	1/8	10	172041000
R23	CACP	10k	1/8	10	172041000
RV1	CMPM	200	3/4	10	130622000
RV2	CMPM	500	3/4	10	130625000
C3	ESTM	10	63	20	219971000
C4	ESTM	2.2	63	20	219962200
C5	ESTM	1.5	63	20	219961500
C6	ESTM	2.2	63	20	219962200
C7	CERM	33p	500	20	241313300
C8	CERM	100p	500	20	241321000
C9	CERM	100p	500	20	241321000

Cct. Ref.	General Description				Solartron Part No.
		Value	V or W	%	
D2	SD3				300522160
D3	SD3				300522160
D4	ZENER	12V	.4	5	300521480
D5	HP5082-6221				300525380
D6	HP5082-6221				300525380
D7	ZENER	3.9V	.4	5	300521420
D8		3.9V	.4	5	300521420
D9	HP5082-6221				300525380
D10	HP5082-6221				300525380
TR1	BCY70				300553590
TR2	BC107				300553320
IC1	LM310H				510090040
IC2	LM301AH				510000620

BOARD 4

CcT REF	General Description	Solartron Part no.
D1	FLV100	300750030
D2	FLV100	300750030
D3	FLV100	300750030
D4	FLV100	300750030
D5	FLV100	300760030

SECTION 7 Specifications

This section contains a copy of the technical specification applicable to this instrument.

This instrument is designed and manufactured to a higher specification than is claimed commercially. In order that the user may benefit as appropriate, this technical manual may relate to a superior performance. In the event of contradications between specifications, no additional claims are made for the instrument above that claimed in the current product data sheet.

Performance specifications: quoted for mains operation.

DC Voltage Ranges

Nominal Range	Full Scale	Input Sensitivity	ACCURACY 90 days	Temperature Coefficient per °C	Input Resistance	Overload Protection
0–100mV	109.99mV	10μV	±0.02% rdg. ±2 digits	±0.004% rdg. ±0.2 digits	1000MΩ	1000V
0–1V	1.0999V	100μV	±0.02% rdg. ±1 digit	±0.004% rdg.	1000MΩ	1000V
0–10V	10.999V	1mV	±0.02% rdg. ±1 digit	±0.004% rdg.	1000MΩ	1000V
0–100V	109.99V	10mV	±0.03% rdg. ±1 digit	±0.004% rdg.	10MΩ	1000V
0–1000V	1099.9V	100mV	±0.03% rdg. ±1 digit	±0.004% rdg.	10MΩ	1000V

AC Voltage Ranges

Nominal Range	Full Scale	Input Sensitivity	ACCURACY 90 days (40Hz to 10kHz)	Temperature Coefficient per °C	Input Impedance	Overload Protection
0–100mV	109.99mV	10μV	±0.2% rdg. ±10 digits	±0.006% rdg. ±0.4 digits	<100pF/1MΩ	1000V
0–1V	1.0999V	100μV	±0.2% rdg. ±4 digits	±0.006% rdg.	<100pF/1MΩ	1000V
0–10V	10.999V	1mV	±0.2% rdg. ±4 digits	±0.015% rdg. ±0.4 digits	<100pF/1MΩ	1000V
0–100V	109.99V	10mV	±0.2% rdg. ±2 digits	±0.015% rdg.	<100pF/1MΩ	1000V
0–700V	700V	100mV	±0.2% rdg. ±2 digits	±0.015% rdg.	<100pF/1MΩ	1000V

Resistance Ranges (Two Terminal)

Nominal Range	Full Scale	Input Sensitivity	ACCURACY 90 days	Temperature Coefficient per °C	Input Current	Overload Protection
0–1kΩ	1.0999kΩ	100mΩ	±0.05% rdg. ±3 digits	±0.003% rdg. ±0.2 digits	100μA	200V
0–10kΩ	10.999kΩ	1Ω	±0.05% rdg. ±1 digit	±0.003% rdg.	100μA	200V
0–100kΩ	109.99kΩ	10Ω	±0.05% rdg. ±1 digit	±0.003% rdg.	100μA	200V
0–1MΩ	1.0999MΩ	100Ω	±0.05% rdg. ±1 digit	±0.003% rdg.	1μA	200V
0–10MΩ	10.999MΩ	1kΩ	±0.25% rdg. ±2 digits	±0.003% rdg.	1μA	200V

DC Current Ranges

Nominal Range	Full Scale	Input Sensitivity	ACCURACY 90 days	Temperature Coefficient per °C	Shunt Resistance	Overload Protection
0–10μA	10.999μA	1nA	±0.05% rdg. ±3 digits	±0.007% rdg. ±0.2 digits	<100Ω	50mA
0–100μA	109.99μA	10nA	±0.05% rdg. ±1 digit	±0.007% rdg.	<100Ω	50mA
0–1mA	1.0999mA	100nA	±0.05% rdg. ±1 digit	±0.007% rdg.	<100Ω	50mA

Interference Rejection

Series Mode

Rejection	dc Measurement
at 50Hz ±1%	>60dB
at 60Hz ±1%	>60dB

Common Mode

Rejection	Measurement	
	dc	ac
at dc	>120dB	>120dB
at 50Hz ±1%	>130dB	>70dB
at 60Hz ±1%	>130dB	>70dB

Maximum Permitted Common Mode Voltage: 500V dc or peak.

Measurement Times

Reading Rate: dc voltage, direct current and resistance 3 readings per second; a.c. voltage 5 readings per 2 seconds.

Display Data

Display: time shared light emitting diodes.
Polarity: '–' for negative polarity, blanked for positive polarity.
Overrange Indication: '1' in 'ten thousands' position and units annunciator flash (on all except resistance measurements).
Units Display: automatic display of mode and range.

Weight

1.1kg (2½lb)

Power Supplies

Mains: 117/234V + 10%–15% 50/60Hz ±1% 2.5VA
Battery: optional accessory (includes charger)

Environment

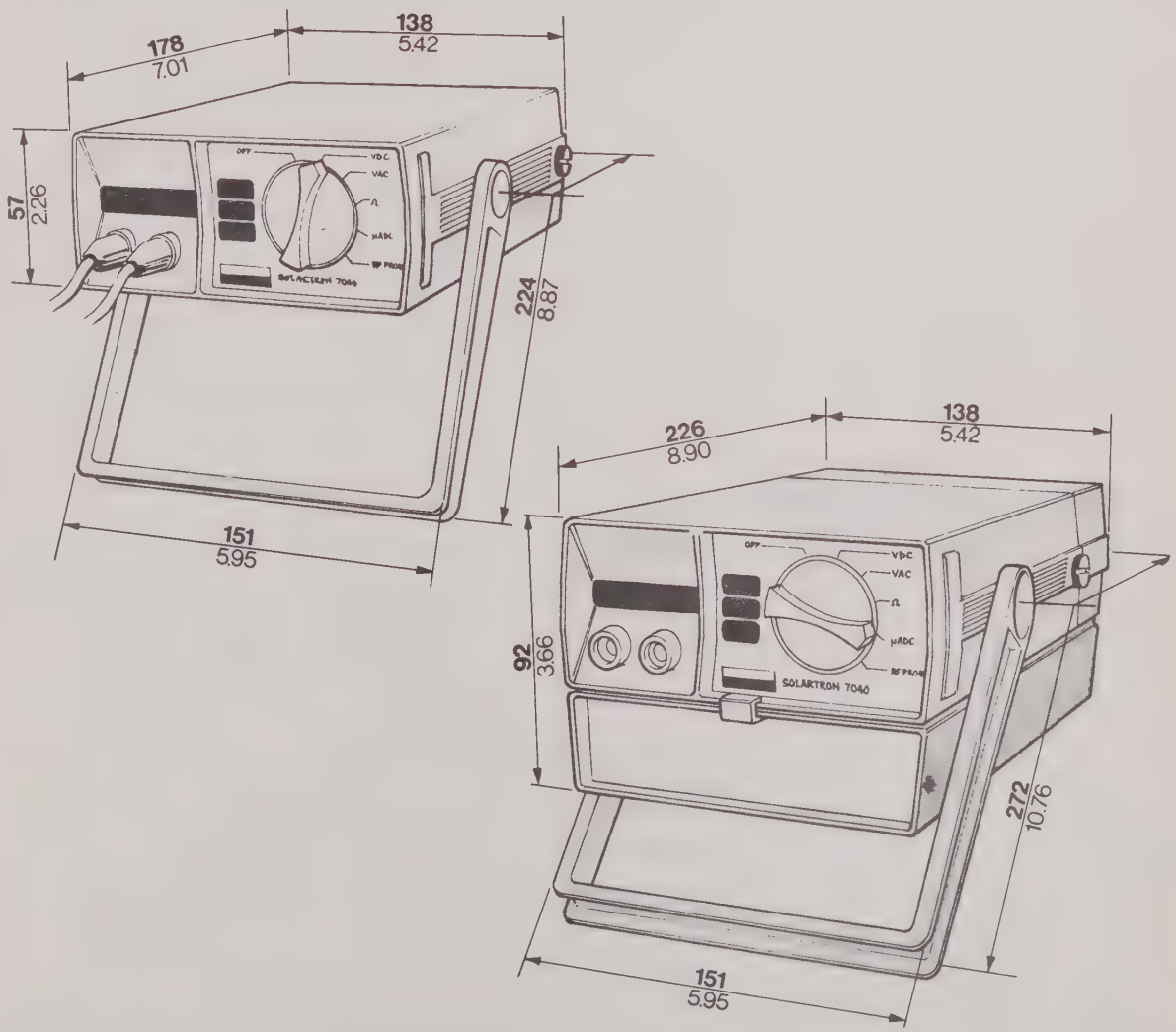
Ambient Temperature, Operating: 0 to +45°C
Ambient Temperature, Storage: –30 to +70°C
Humidity: 70% at 40°C

Nato Stock Number: 6625–25–115–9926

Standard Accessories

Carrying case, input leads, mains lead, crocodile clips, flexible probes and operating manual.

Dimensions



Specifications for the optional accessories, which are fully described in part 2, are as follows:-

RF Probe 70402—Voltage Ranges

Nominal Range	Full Scale	Input Sensitivity	ACCURACY 90 days (at 10kHz datum)	Frequency Response	Input Impedance	Overload Protection
100mV–1V	1.0999V	100μV	±0.5% rdg. ±0.5% fs	-0.5dB 5kHz to 50MHz	~10MΩ/8pF	300V pk
1V- 10V	10.999V	1mV	±0.5% rdg. ±0.5% fs	-3dB 1kHz to 300MHz	~10MΩ/5pF	300V pk

Low Level Resistance Unit 70404—Resistance Ranges (Four Terminal)

Nominal Range	Full Scale	Input Sensitivity	ACCURACY 90 days	Temperature Coefficient	Input Current	Overload Protection
0–1Ω	1.0999Ω	100μΩ	±0.1% rdg. ±5 digits	±100ppm/°C	100mA	200V pk
0–10Ω	10.999Ω	1mΩ	±0.1% rdg. ±5 digits	±100ppm/°C	10mA	200V pk
0–100Ω	109.99Ω	10mΩ	±0.1% rdg. ±5 digits	±100ppm/°C	1mA	200V pk
0–1kΩ	1.0999kΩ	100mΩ	±0.1% rdg. ±5 digits	±100ppm/°C	1mA	200V pk

Current Shunt 70403—DC Current Ranges

Nominal Range	Full Scale	Input Sensitivity	ACCURACY 90 days	Temperature Coefficient	Voltage Drop	Overload Protection
0–10mA	10.999mA	1μA	±0.1% rdg. ±5 digits	±100ppm/°C	<300mV	Fuse
0–100mA	109.99mA	10μA	±0.1% rdg. ±5 digits	±100ppm/°C	<300mV	Fuse
0–1A	1.0999A	100μA	±0.25% rdg. ±5 digits	±100ppm/°C	<300mV	Fuse
0–10A	10.999A	1mA	0.4% rdg. ±5 digits	±100ppm/°C	<300mV	Fuse

Current Shunt 70403—AC Current Ranges

Nominal Range	Full Scale	Input Sensitivity	ACCURACY 90 days (40Hz to 1kHz)	Temperature Coefficient	Voltage Drop	Overload Protection
0–10mA	10.999mA	1μA	±0.1% rdg. ±10 digits	±160ppm/°C	<300mV	Fuse
0–100mA	109.99mA	10μA	±0.1% rdg. ±10 digits	±160ppm/°C	<300mV	Fuse
0–1A	1.0999A	100μA	±0.4% rdg. ±10 digits	±160ppm/°C	<300mV	Fuse
0–10A	10.999A	1mA	±0.4% rdg. ±10 digits	±160ppm/°C	<300mV	Fuse

APPENDIX

This section contains specialised selection procedures and/or test equipment to facilitate servicing.

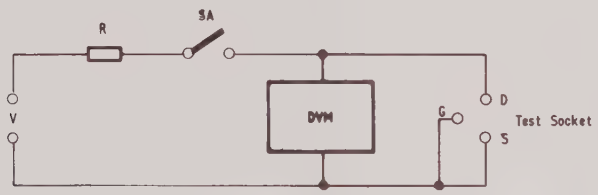
F.E.T. SELECTION PROCEDURE

Purpose

To select four F.E.T.'s type U1899E with RoN matched to within 1Ω at a drain-source current of 100μA.

Test Procedure

The following test procedure should be carried out using the test circuit shown below or Solartron Test Equipment TG1100/1.



TEST CIRCUIT

$$\left.\begin{array}{l} V = 10V \\ R = 100K \end{array}\right\} \quad \frac{V}{R} = 100\mu A \pm 0.2\%$$

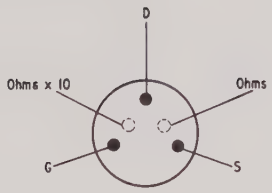
(a) Devices to be tested should be allowed to settle to the ambient temperature of the chamber in which the matching operation is to be done. This temperature should be 23°C ± 1°C.

(b) Place the device under test in the test socket using tweezers or pliers to ensure that its temperature is not raised by handling.

(c) Press switch SA and note DVM reading.
Use the relation 1mV = 10Ω to calculate the RoN value.

(d) Mark the top of the device with two coloured dots of paint as shown in following view employing the standard colour code.
RoN to be given to nearest whole number, e.g.

45.6Ω	YELLOW-BLUE
46.3Ω	YELLOW-BLUE
46.5Ω	YELLOW-VIOLET



TOP VIEW

(e) Select sets of four devices, each with the same colour code.

Colour Code

0	Black
1	Brown
2	Red
3	Orange
4	Yellow
5	Green
6	Blue
7	Violet
8	Grey
9	White

TEST BOX

The following item of equipment should be used to facilitate testing.

Components List

1 - 2p4w wafer switch

1 - 1MΩ $\frac{1}{2}$w 10% resistor

1 - 1μf 100V capacitor

1 - 3V battery (2 'c' cells)

1 - 1.5KΩ potentiometer

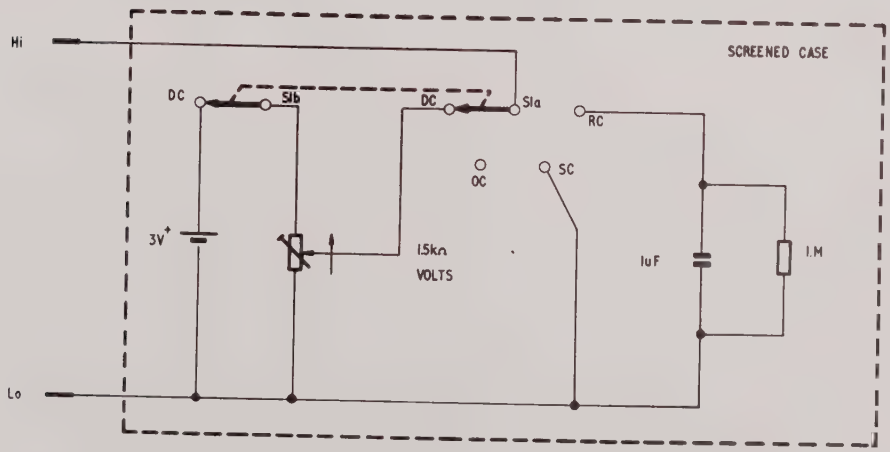
2 - 4mm Plugs

1 - Screened Case

Circuit Diagram

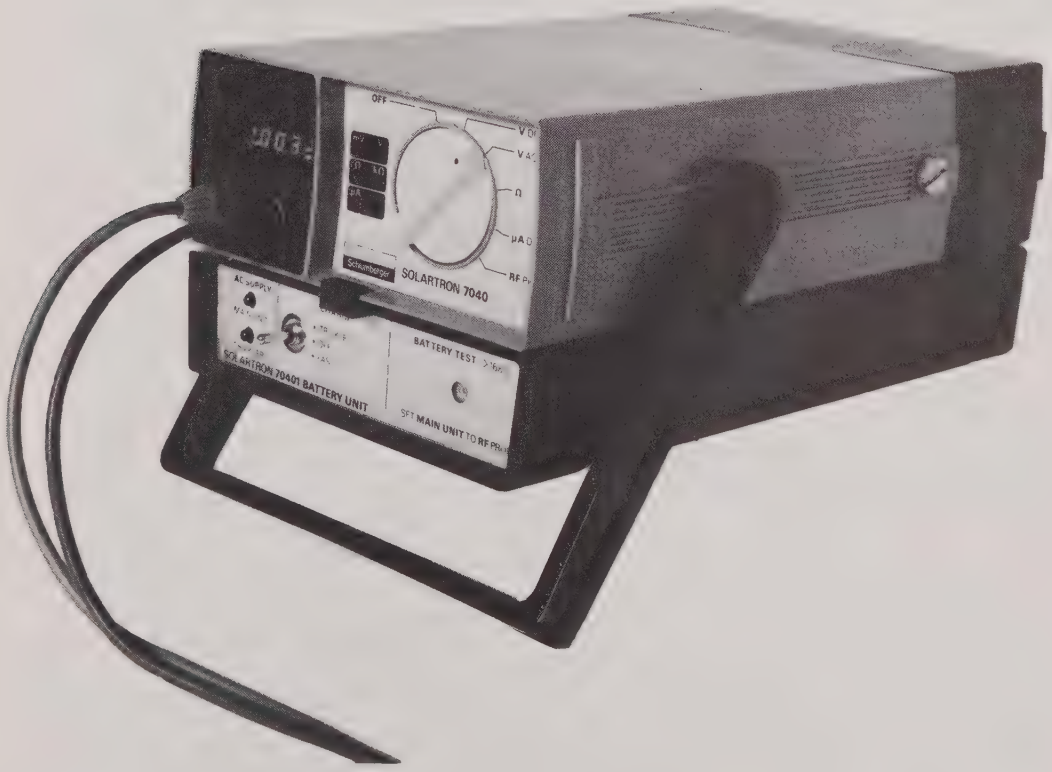
Keep all leads short.

Plugs 'Hi' & 'Lo' should be arranged to plug directly into the DMM front panel input terminals in place of the normal input leads.



Part 2 Accessory Units

SECTION 1 General
SECTION 2 70401 Battery Unit
SECTION 3 70402 RF Probe
SECTION 4 70403 Current Shunt
SECTION 5 70404 Low-Level Resistance Unit



Part No. A26100010

Nov. 1973

Schlumberger

THE SOLARTRON ELECTRONIC GROUP LIMITED
FARNBOROUGH HAMPSHIRE ENGLAND GU14 7PW
TEL. FARNBOROUGH 44433 (STD 0252)
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TECHNICAL MANUAL

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SECTION 1 General

GENERAL INTRODUCTION

This manual should be read in conjunction with the 7040 DMM Technical Manual.

The Accessory Units extend the versatility of the 7040 DMM by providing the following additional facilities.

70401 BATTERY UNIT

This unit is a Battery Pack which enables the DMM to be operated without a mains source for approximately 7 hours.

The DMM may also be operated on mains while the batteries are being charged.

70402 RF PROBE

This unit provides an RF measurement capability of up to 300MHz of voltages from 100mV to 11V.

The DMM displays the rms value when in RF Probe position.

70403 CURRENT SHUNT

This unit extends the current measuring capability of the DMM from 1mA to 10A, DC or AC (40Hz to 1kHz).

The DMM operates in either the DC Volts mode or AC Volts mode.

70404 LOW LEVEL RESISTANCE UNIT

This unit extends the resistance measurement capability of the DMM by providing 3 additional ranges of 1Ω, 10Ω and 100Ω, with a maximum resolution of 100μΩ

The 4 terminal measurement technique is used and the DMM operates in DC Volts mode.

ACCESSORY FITTING INSTRUCTIONS

Before attempting to fit the Accessory Unit to the DMM, ensure that the "PRELIMINARY CHECKS" detailed under each Accessory Unit have been carried out, together with "PRELIMINARY ADJUSTMENTS" for the DMM as follows.

(a) Check that the voltage selection indicator (red pip) is fitted in the correct voltage range position. If necessary, remove the two rear thumb-screws and then carefully remove the back panel. Reposition the voltage selector as required.

(b) Connect a suitable connector to the input mains lead as follows:-

Brown	-	Live
Blue	-	Neutral
Yellow/Green	-	Earth

FITTING PROCEDURE

(a) Loosen the two thumb screws located at the rear of the accessory unit, remove the two nuts and pull the screws back such that the screwed end is flush with the rear of the case.

(b) Slide the DMM into the accessory unit and push firmly home into the rear power socket.

(c) Clip the spring loaded catch onto the lower lip of the DMM front panel.

(d) Tighten the two rear screws taking care not to distort the rear casing.

Parts List

COMPONENT PARTS LIST

ABBREVIATIONS

Circuit References

B	Battery
C	Capacitor (μF)
CSR	Thyristor
D	Diode
FS	Fuse
IC	Integrated Circuit
L	Inductor
LP	Lamp (including Neon)
LK	Link
M	Meter
MSP	Mains Selector Panel
PL	Plug
R	Resistor (Ω)
RL	Relay
S	Switch
SK	Socket
T	Transformer
TP	Terminal Post (or Test Point)
TR	Transistor
V	Valve
X	Other Components

Also Used:-

RNL	Non Linear Resistor (Ω)
RV	Variable Resistor (Ω)

Component Composition

FIXED RESISTORS

Carbon Composition	CACP
Carbon Film	CAFM
Cracked Carbon	CKCA
Metal Film	MEFM
Metal Oxide	MEOX
Power Wirewound	POWW
Precision Wirewound	PRWW
Temperature Sensitive	TEMP
Thick Film	TKFM
Thin Film	TNFM
Voltage Sensitive	VOLT

Component Composition (Cont'd)

VARIABLE RESISTORS

Wirewound Preset Single Turn	WWPS
Wirewound Preset Multiturn	WWPM
Wirewound Front Panel Single Turn	WWFS
Wirewound Front Panel Multiturn	WWFM
Carbon Preset Single Turn	CAPS
Carbon Preset Multiturn	CAPM
Carbon Front Panel Single Turn	CAFS
Carbon Front Panel Multiturn	CAFM
Cermet Preset Single Turn	CMPS
Cermet Preset Multiturn	CMPM
Cermet Front Panel Single Turn	CMFS
Cermet Front Panel Multiturn	CMFM

CAPACITORS

Air	AIR
Aluminium Electrolytic	ALME
Aluminium Solid	ALMS
Polycarbonate	CARB
Ceramic	CERM
Polyester Foil	ESTF
Polyester Metallised	ESTM
Glass	GLAS
Mica	MICA
Metallised Lacquer	MLAC
Paper Foil	PAPF
Paper Metallised	PAPM
PTFE	PTFE
Polypropylene Film	PYLN
Polystyrene	STYR
Tantalum Dry	TAND
Tantalum Foil	TANF
Tantalum Wet	TANW

Component Parts List

for

Printed Circuit Board

A2619001

(Rectifier Unit)

Cct Ref.	General Description				Solartron Part No.
D5	BAY72				300524530
D6	BAY72				300524530
D7	IN5615				300525390
D8	IN5615				300525390
D9	BAY72				300524530
D10	BAY72				300524530
D11	Quad (W-04)				300524700
R9	CACP	10	1/8W	10%	172011000
R11	CACP	10	1/8W	10%	172011000
R13	MEOX	470	1/2W	5%	193524700
R14	MEOX	2.2k	1/2W	5%	193532200
C3	CERM	0.047	25V	+50% -25%	241944700
C4	CERM	3300p	500V	20%	241333300
C5	CERM	0.047	25V	+50% -20%	241944700
C6 to C8	CERM	3300p	500V	20%	241333300
L1 to L5	Ferrite Bead				309010060

Component Parts List

for

Printed Circuit Board

A2619002

(Inverter Unit)

Cct Ref.	General Description				Solartron Part No.
R1	CACP	220k	1/8W	10%	172052200
R2	CACP	3.9k	1/8W	10%	172033900
R3	CACP	4.7k	1/8W	10%	172034700
R4	MEOX	1k	1/4W	5%	195631000
R5	MEOX	1k	1/4W	5%	195631000
R6	MEOX	120	1/4W	5%	195621200
R7	MEOX	120	1/4W	5%	195621200
R8	CACP	150	1/8W	10%	172021500
C1	TAND	6.8	35V	20%	266066800
C2	CERM	0.047	25V	+50% -25%	241944700
T2	Output				309606302
T3	Inverter				309606202
D1	SD3				300522160
D2	BAY72				300524530
D3	SD3				300522160
D4	SD3				300522160
D12	SD3				300522160
D13	SD3				300522160
TR1	BCY70				300553590
TR2	BSV64				300554540
TR3	BSV64				300554540
F1	Slo Blo	0.5A			360190130

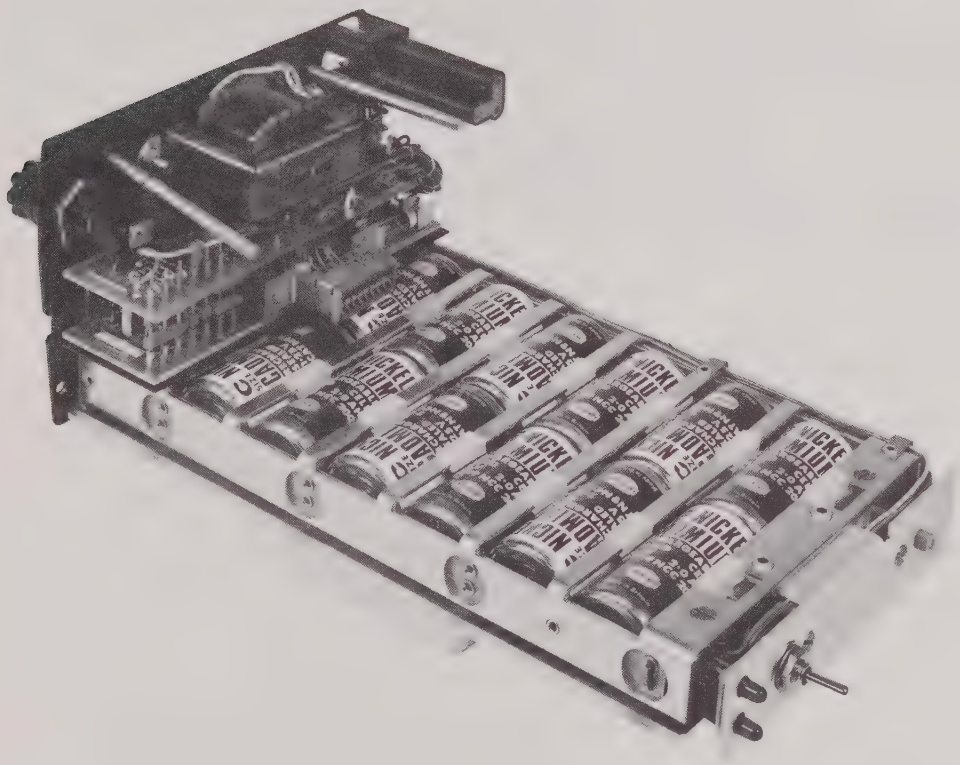
Component Parts List

for

Battery Unit 70401 Sub-Assembly

Cct. Ref.	General Description			Solartron Part No.
R15	1M	1/8W	1%	191261002
C9	1000	10V		273191000
D14	LED mV 5024			300750060
D15	LED mV 5024			300750060
T1	Mains			309606004
B1 to B14	Battery (14 off)			310010100
F2	Fuse 5B 1¼ 100mA			360/03030

SECTION 2 70401 BATTERY UNIT



INTRODUCTION

The unit is a Battery Pack which when fitted to the 7040 DMM enables the instrument to be used without a mains source for approximately 7 hours.

The unit has its own mains charger which may be used to charge the battery either with the DMM fitted or separately without the DMM.

The DMM may be used while charging is taking place. A battery test facility is provided.

PRELIMINARY CHECKS

(1) Check that the voltage selection indicator is set to the correct mains supply voltage as indicated by the red market on the back panel.

To change the setting, proceed as in ACCESS AND BATTERY INSTALLATION.

(2) Check the presence and value of the mains fuse located in the fuse holder on the back panel:

115V	setting	200mA or 250mA	SLO BLO
230V	setting	100mA	SLO BLO

(3) Remove the rear DMM thumb-screws and carefully remove the back panel. Remove the cover plate (lower centre of the back panel) exposing Board 1 edge connector. Reposition the back panel and replace the thumb-screws.

(4) If the batteries have not been fitted refer to ACCESS AND BATTERY INSTALLATION.

If they are fitted (the weight of the Unit with batteries is 2kg (4.4 lbs) and without batteries 0.9kg (2 lbs), fit the DMM to the 70401 BATTERY UNIT as detailed in "ACCESSORY FITTING INSTRUCTIONS".

OPERATION

(1) Battery Test

(a) Set the CHARGE switch to OFF and select "RF Probe" on the DMM.

(b) Connect the +ve DMM Input Lead to the BATTERY TEST socket.

(c) Check that the DMM reading is greater than the minimum stated on the Battery Unit Front Panel; a reading below this indicates that charging is necessary. See para (3) which follows.

(2) Mains/Battery Changeover

Change from mains to battery operation is fully automatic and the combined DMM/Battery Unit can derive its power from the mains whenever this is connected.

When the mains is removed, changeover to battery power is immediate.

The POWER lamp on the Battery Unit indicates when the mains supply is connected to either unit.

(3) Charging

The batteries may be charged in the combined DMM/Battery Unit or in the Battery Unit alone with no change in the charging rate.

Ideally, TRICKLE CHARGE should be used to keep the batteries in a high state of charge, while FAST CHARGE should be selected if the batteries have been significantly run down.

Fully discharged batteries may be completely recharged in 16 hours at the FAST rate. This permits overnight charging for daily operation on batteries.

Caution. Do not use FAST CHARGE for continuous periods exceeding 72 hours.

(4) Dry Battery Use

In exceptional circumstances Dry Batteries may be used; for example the EVER READY HP11.

Caution. Do not attempt to charge dry batteries. Using the HP11 type of battery and operating the DMM for short periods of up to ½ hour per day, a battery life of 4 hours can be expected.

ACCESS AND BATTERY INSTALLATION

Remove the case for any one of the following operations:

(a) to change the voltage selector;

(b) to check or change the 500mA fuse (Battery Fuse) on Board 2;

(c) to check or install the 14 IEC KR 27/50 (C size) 1.25V batteries.

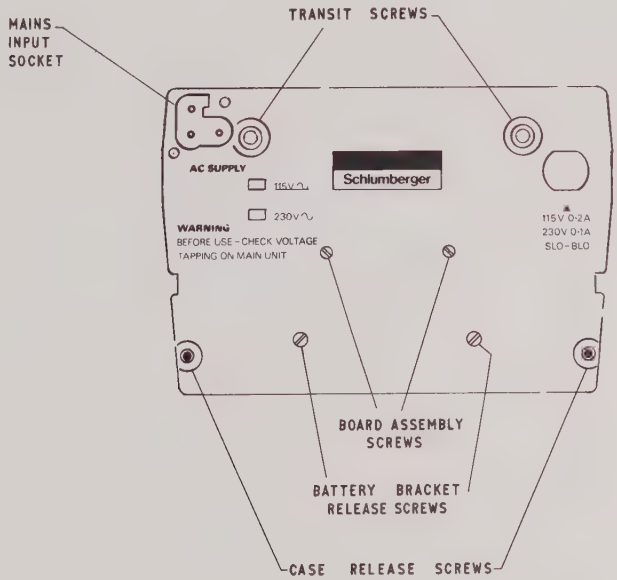


Fig. 2.1 Battery Unit Back Panel

(1) Case Removal

(a) Remove the mains lead and DMM if fitted.

(b) Remove the two case securing screws located on the back panel lower corners.

(c) Slide the Battery Unit from its case by pressing the 8-way socket through the case aperture.

(2) Changing Voltage Selector

(a) Remove the main lead and case as detailed in CASE REMOVAL above.

(b) Remove the two Board Assembly Screws.

(c) Pivot the Board assembly from the centre of the back panel.

(d) Reposition the red voltage selector to the correct setting.

(e) Reposition the Board Assembly and replace the Board Assembly Screws.

(f) Do not forget to check that the DMM mains selection is set to the correct setting.

(3) **Battery Changing And Installation**

(Batteries B1-B14, Part No. 310010100. 14 required for complete set)
For battery changing follow all steps below.
For battery installation follow all steps below except (vi).

(a) Remove the mains lead and case as in CASE REMOVAL above.

Caution. Check the side panel notations "OBSERVE BATTERY POLARITY". The battery centre pole is + and the case is −.

(b) Place the unit upside down on a firm surface.

(c) Remove the two battery bracket screws located on the back panel (see Fig. 2.1).

(d) Remove the two battery bracket screws located on the battery bracket beneath the front panel (see Fig. 2.2).

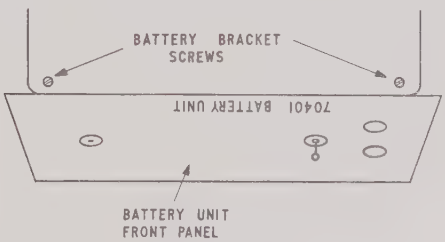


Fig. 2.2 Battery Bracket Screws (front) Location.

(e) Remove the battery bracket.

(f) Lever each spent battery from its housing.

(g) Place the new batteries in position, carefully observing polarity as detailed under Caution in 3 (a); WRONG POLARITY WILL CAUSE DAMAGE.

(h) Replace the battery bracket and secure the two sets of screws.

(j) Replace the case and securing screws.

SPECIFICATION

ENVIRONMENT

Working Temperature Range	:	0 to +45^{O}C*
Storage Temperature Range	:	-30 to 70^{O}C*
Maximum Relative Humidity	:	70% at 40^{O}C

POWER SUPPLY

Mains Voltage	:	117/234V +10%, -15%
Frequency	:	45/65Hz
Consumption	:	8VA

Fuse	:	117V, 200mA or 250mA Part No. 360103050. 234V, 100mA Part No. 360103030.

BATTERIES

Type	:	14 Nickel Cadmium Cells,* IEC K27/50 ("C" Size) 1.25V/cell, 2AH rating. Part No. 310010100 (B1-B14, Complete Set)
Charge Life	:	approximately 7 hours*
Fuse	:	500mA Part No. 360190130

*NOTE 1. Figures are based on typical battery performance quoted by the battery manufacturer.

2. Temperature limitations will vary according to manufacture, whose specifications should always be consulted.

DIMENSIONS

Width	:	130mm (5.12 in)
Height *(Front Panel)*	:	32mm (1.25 in)
Height *(Back Panel)*	:	89mm (3.5 in)
Length	:	228mm (9 in)
Weight	:	with batteries 2kg (4.4 lbs) without batteries 0.9kg (2 lbs)

ACCESSORIES

Mains Lead Assembly	:	Part No. 489600202

TECHNICAL DESCRIPTION

The following circuit descriptions refer to the adjacent blocked circuit diagram, each coloured area of which corresponds to each of the following sub-headings.

RECTIFIER

A transformer/full wave bridge rectifier assembly providing a source of dc current for charging the 14 internal Ni-Cad cells B1-14. Selector S1 provides two charging rates as follows:-

FAST	200mA
TRICKLE	20mA

The CHARGER lamp D2 is illuminated with either rate selected.

INVERTER

When the 7040/70401 combination is mains powered, the -6V inhibit signal produced by the 7040 DMM inhibits the inverter operation via D12 and D13. The MAIN UNIT lamp D1 is illuminated.

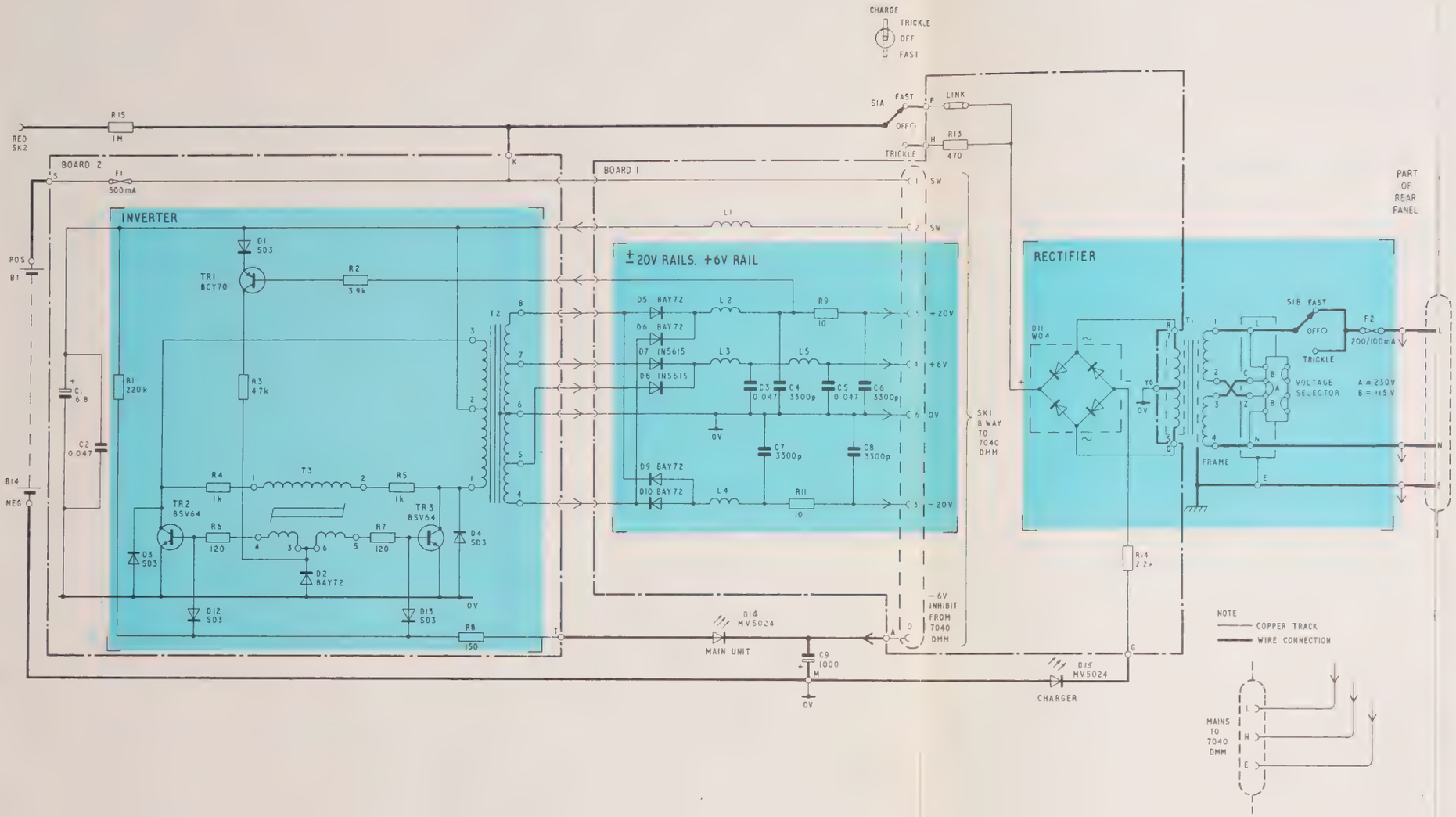
When mains power to the 7040/70401 combination is not present and the 7040 is switched ON, the -6V inhibit signal is not present thus unclamping the inverter TR2/TR3. Pins 1 and 2 of SK1 are linked via the 7040 mains switch thus the battery voltage is fed to TR1 which forces either TR2 or TR3 to turn on thus starting inverter operation.

As the +20V rail rises, TR1 is cut off thus removing the inverter starting signal. The 25kHz output is transformed via T2 to form the ±20V and +6V rails for operating the 7040 unit.

±20V RAILS, +6V RAIL

The outputs from T2 are rectified and via SK1 provide power to the 7040 DMM. These outputs are stabilised by the 7040 power supply circuitry as normal.

D. A2617001



Battery Unit Circuit Diagram A2617001

70401 TEST PROCEDURE

1. TEST EQUIPMENT

(a) Dummy load, *e.g. TG1306.*

(b) Digital Multimeter *e.g. Solartron 7040.*

(c) 0.1Ω shunt resistor *e.g. Cropico standard.*

(d) Multimeter *e.g.* AVO *model 8*

(e) Oscilloscope *e.g. Solartron Type 1740 or Solartron A100.*

2. TEST PROCEDURE

2.1 To Check Initial Charge

(a) After removing the 500mA fuse set the multimeter to the 1 amp dc range and connect it across fuse contacts.

(b) Set charge switch to FAST, first checking that the mains voltage tap is set to 230V.

(c) Plug in the DMM and switch on 230V mains supply. Check that the initial charge current is between 200mA and 300mA.

(d) Switch OFF and replace fuse.

(e) Place battery on charge for 2 hours.

2.2 To Check Charging Rate

(a) With the unit switched OFF and fuse removed, set multimeter to the 1 amp DC range and connect it across the fuseholder terminals.

(b) Switch unit ON and verify that the charging rate lies between 130mA and 250mA over a mains range of 200V to 259V. Check that the CHARGER lamp illuminates during test.

(c) Switch the unit OFF and change the mains tapping point from 230V to 117V.

(d) Ensure that the mains supply is 117V and switch unit ON. Check that the charging rate lies between 130mA and 250mA over the mains range of 100V to 129V and that the CHARGER lamp illuminates during test.

(e) Set Charge switch to TRICKLE and verify that the CHARGER lamp remains illuminated.

(f) Check that the charge rate lies between 15mA and 25mA.

(g) Replace the fuse and connect the unit directly to the 230V mains supply.

(h) Connect the oscilloscope across T3 terminates and check that no waveform is present and that MAIN UNIT lamp illuminates.

2.2 Efficiency

(a) Check that the fully charged battery voltage is not less than 18.5V.

(b) Remove the 500mA fuse and connect the 0.1Ω shunt resistor between the fuseholder contacts.

(c) Connect the DMM across the same fuseholder contracts in parallel with 0.1Ω shunt resistor.

(d) Measure the voltage drop across the 0.1Ω shunt resistor and determine the battery power consumption. Check that this is between 4.6W and 5.4W.

(e) Plug in TG1306 and connect the oscilloscope between T2 secondary and 0V.

(f) Switch TG1306 ON and check that the frequency of the inverter lies between 20kHz and 30kHz.

(g) Remove the shunt, DMM and oscolloscope and replace the fuse.

(h) Using TG1306, check the voltages of the +20V, −20V and +6V rails. By using the V2/R table quoted on TG1306 determine the power consumed by the load.

Note: Loads of TG1306 = 300Ω on 20V rails
= 20Ω on 5V rail
Loads of TG1306A = 290Ω on 20V rails
(Soak load) = 40Ω on 5V rail

Determine the efficiency rating of the unit by adding T2 secondary power consumption, then divide this by the battery power consumption. The efficiency should exceed 72%.

Example:

T2 secondary power consumption

+20V rail	=	21.85V x 73mA	= 1.59W
−20V rail	=	21.81V x 72mA	= 1.57W
+ 5V rail	=	5.75V x 136mA	= 0.78W
			3.94W

Battery power consumption = 18.73V 268mA = 5.02W.

Hence efficiency = $\frac{3.94}{5.02}$ = 78.5%

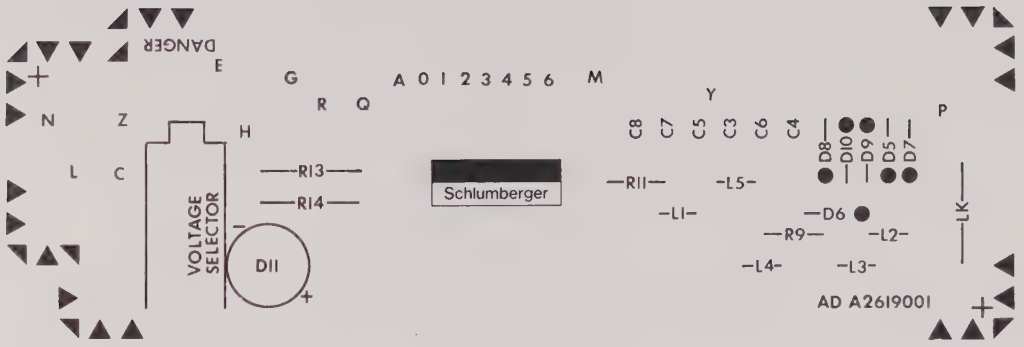


Fig. 2.3 Battery Unit - Inverter Board Component Layout

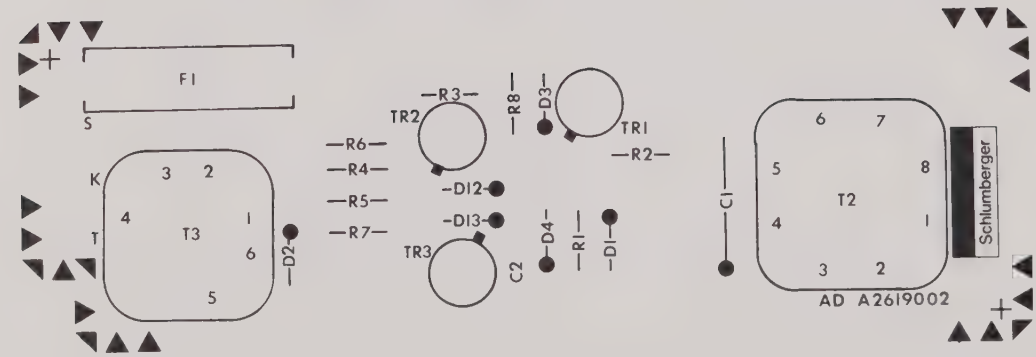
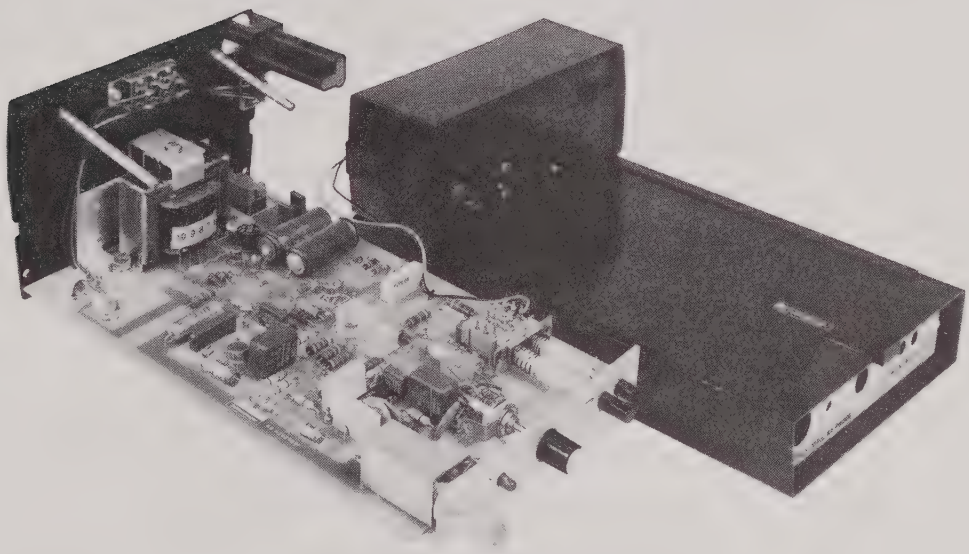


Fig. 2.4 Battery Unit - Rectifier Board Component Layout

SECTION 3 70402 RF Probe



INTRODUCTION

This unit comprises 2 RF PROBE HEADS and an AC/DC CONVERTER.

These probe heads form impedance converters for the applied RF converting the input impedance of the instrument from 1MΩ (X1 Probe head) or 10MΩ (X10 Probe head).

When fitted it enables an RF voltage of up to 300MHz to be measured (rms calibrated) and displayed by the DMM in "RF Probe" Mode.

Nominal RF Ranges are:-

x1 Probe Head	100mV to 1.1V rms
x10 Probe Head	1V to 11V rms.

PRELIMINARY CHECKS

(1) Check that the voltage selection indicator has been set to the value of the supply voltage as indicated by the red marker on the back panel.

Should this require resetting proceed as follows:-

(a) remove the two case securing screws on the lower corners of the back panel;

(b) slide the outer case off;

(c) slacken the three mains transformer (T1) securing screws so that the voltage selector (red block) can be repositioned and the red marker fitted to the back panel window to indicate the correct mains voltage;

(d) Check the presence and value of the mains fuse located in the open holder on the printed circuit board;

		Part No.
100mA	SLO BLO	360190120

(e) tighten T1 securing screws and replace the case and the case securing screws.

(2) Set the DMM to OFF and fit the DMM to the 70402 RF PROBE as detailed in "ACCESSORY INSTRUCTIONS".

OPERATION

(1) Plug in the mains lead firmly to the RF PROBE and apply a mains input.

(2) The mains ON/OFF switch (SUB UNIT POWER) for the RF PROBE is located on the back panel and operates independently of the DMM switch. Set the ON/OFF switch to ON.

(3) Select "RF Probe" on the DMM switch and "Sub Unit" on the RF PROBE front panel.

(4) Select either the x1 or x10 PROBE HEAD according to the amplitude of RF signal to be measured and fit the BNC plug to the RF PROBE.

PROBE HEAD	RANGE
x1	100mV to 1.1V
x10	1V to 11V

Fit a Bayonet Tip and Earth Lead to the selected PROBE HEAD.

Note. PROBE HEADS must be used with the PROBE UNIT of the same serial number.

(5) Connect the Bayonet tip and Earth Lead and adjust the ZERO control for a zero reading on the DMM.

(6) Caution. The applied RF voltage must not exceed ± 300V peak.

(7) Interpretation of Reading.

x1 PROBE HEAD	DMM Reading
x10 PROBE HEAD	DMM Reading x10

SPECIFICATION

Environment

Working Temperature Range	:	0 to 45°C.
Storage Temperature Range	:	−30 to +70°C.
Maximum Relative Humidity	:	70% at 40°C.

POWER SUPPLY

Voltage	:	117/234V + 10% – 15%.
Frequency	:	50/60Hz ± 2%.
Consumption	:	6VA.
Fuse	:	100mA SLO BLO Part No. 360190120

FREQUENCY RESPONSE

Relative to a 10kHz datum the frequency response is within the following limits:

1kH to 5kHz	5kHz to 50MHz	50MHz to 300MHz
+0dB to –3dB	+0dB to –0.5dB	+0dB to –3dB

ACCURACY For 90 Days, Basic 7040 Included

10kHz ± 0.5% of reading, ± 0.5% of range.

PROTECTION x1 and x10 Probe Head

Maximum Input Voltage : ± 300V peak

RANGES

Probe Head	Range	Resolution	Input Impedance
x1	100mV to 1.1V rms	100μV	approx. 8pF/10MΩ
x10	1V to 11V	1mV	approx. 5pF/10MΩ

DIMENSIONS

Width	:	130mm (5.12 in)
Height *(Front Panel)*	:	32mm (1.25 in)
Height *(Back Panel)*	:	89mm (3.5 in)
Length	:	228mm (9 in)
Weight	:	0.9kg (21b)

ACCESSORIES

	Part No.
Clip Hook Assy (2 off)	A2620014
Bayonet Tip Assy (2 off)	A2620017
Earth Lead Assy	A2620019

TECHNICAL DESCRIPTION

The following circuit descriptions refer to the adjacent blocked circuit diagram each coloured area of which corresponds to each of the following sub-headings.

X1 AND X10 PROBE HEADS

These two probes form impedance converters for the applied RF signal converting from 1MΩ (10MΩ) to 75Ω at the BNC socket. RV1 is set for a gain of approximately 0.4 (x1) or 0.04 (x10) at 50kHz.

RECTIFIER AND BUFFER AMPLIFIER

Rectification of the applied RF input occurs at the base-emitter junction of IC3b. The current in IC3b increases and a fall in voltage appears at the negative input of IC1, resulting in a positive voltage at the output of this amplifier.

CHOPPER AMPLIFIER AND FILTER

This positive voltage from the Rectifier Buffer amplifier circuitry is converted to a 10kHz square wave by means of the switching waveform produced by the chopper circuit and applied to the base of IC3e, with the square wave peak to peak amplitude proportioned to the dc voltage.

IC2 and associated components form a three-pole active filter which converts the square wave input to a sine wave output by filtering out all harmonics. The resultant 10kHz sine wave, of 1/10 the amplitude of the square wave at TP5, appears at the base of IC3a and is rectified by the base-emitter diode. This feedback voltage is used to balance the input stage IC3a.

NOTE

The above process takes place the instant the RF signal is applied so that the long-tailed pair IC3a IC3b always appear balanced. However, current must be drawn first from the IC1 output in order to maintain this condition and the voltage driving this current through load R14/IC3e is the voltage which appears at the output terminals, driving the 10KΩ load represented by the DMM. This voltage varies proportionally to the input RF amplitude.

CHOPPER DRIVE

RV4 sets the chopper frequency to 10kHz. The mark/space ratio should be 1:1 and the amplitude at TP3 should be greater than 0.5V peak to peak.

± 18V STABILISED SUPPLY

Two conventional series regulated power supplies each fed from a common full wave bridge rectifier D4.

As the zener current for each supply is normally derived from the other rail, it would be possible that neither would stabilise on switch-on.

R33, R34 and D3 provide a by-pass path to ensure that the +18V rail stabilises on switch-on which in turn will enable the −18V rail to stabilise.

70402 TEST PROCEDURE

ENVIRONMENT

The ambient temperature should be between 20°C and 25°C. The relative humidity should be between 40% and 60% at the ambient temperature.

1. TEST EQUIPMENT

1.1 Oscilloscope with 5mV/cm sensitivity, *e.g. SOLARTRON A100.*

1.2 Multimeter, *e.g. Solartron 7040.*

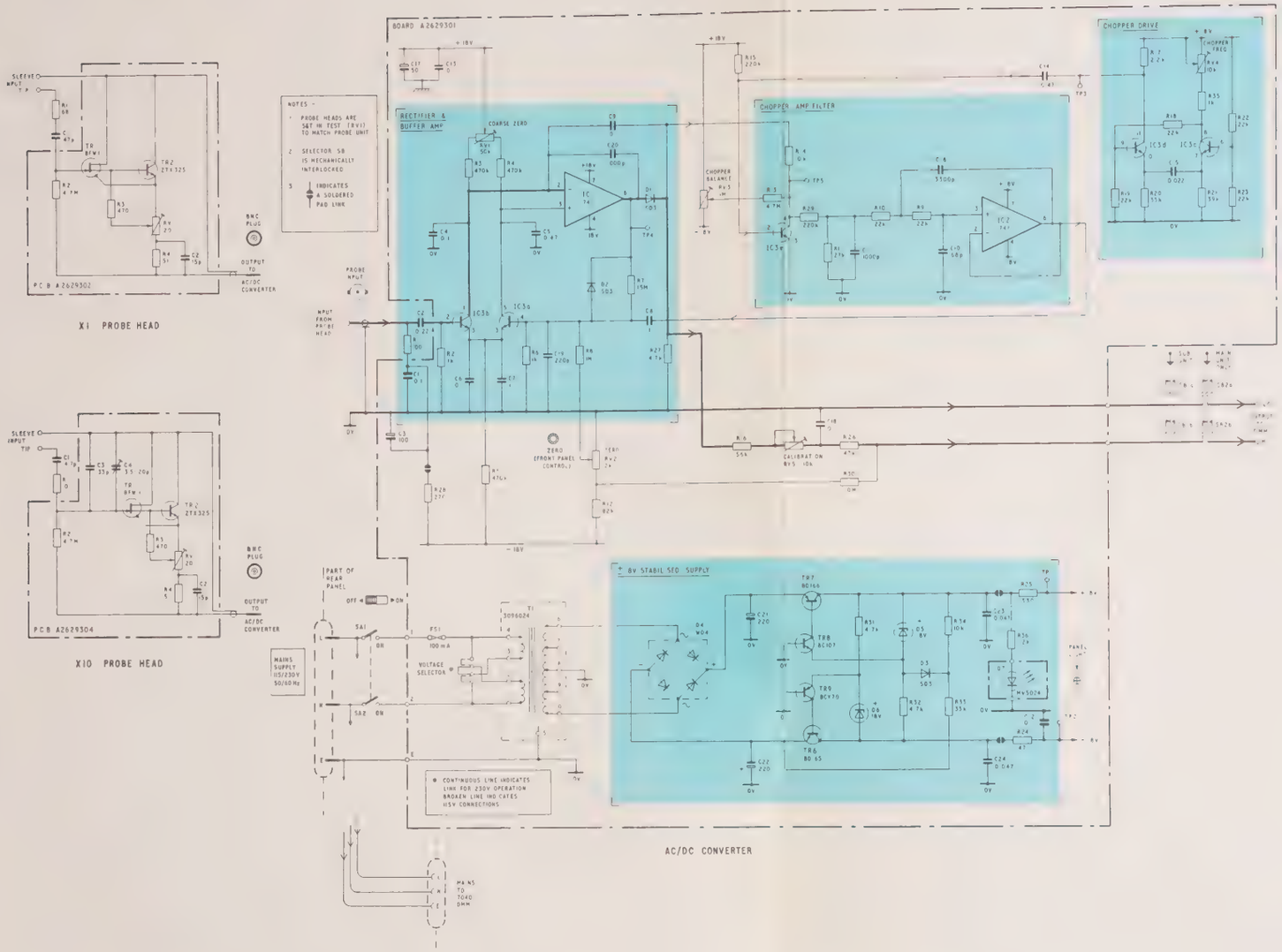


Fig. 3.0 RF Probe Circuit Diagram A2627001

(A simplified block diagram of this circuit is shown in Fig. 3.1)

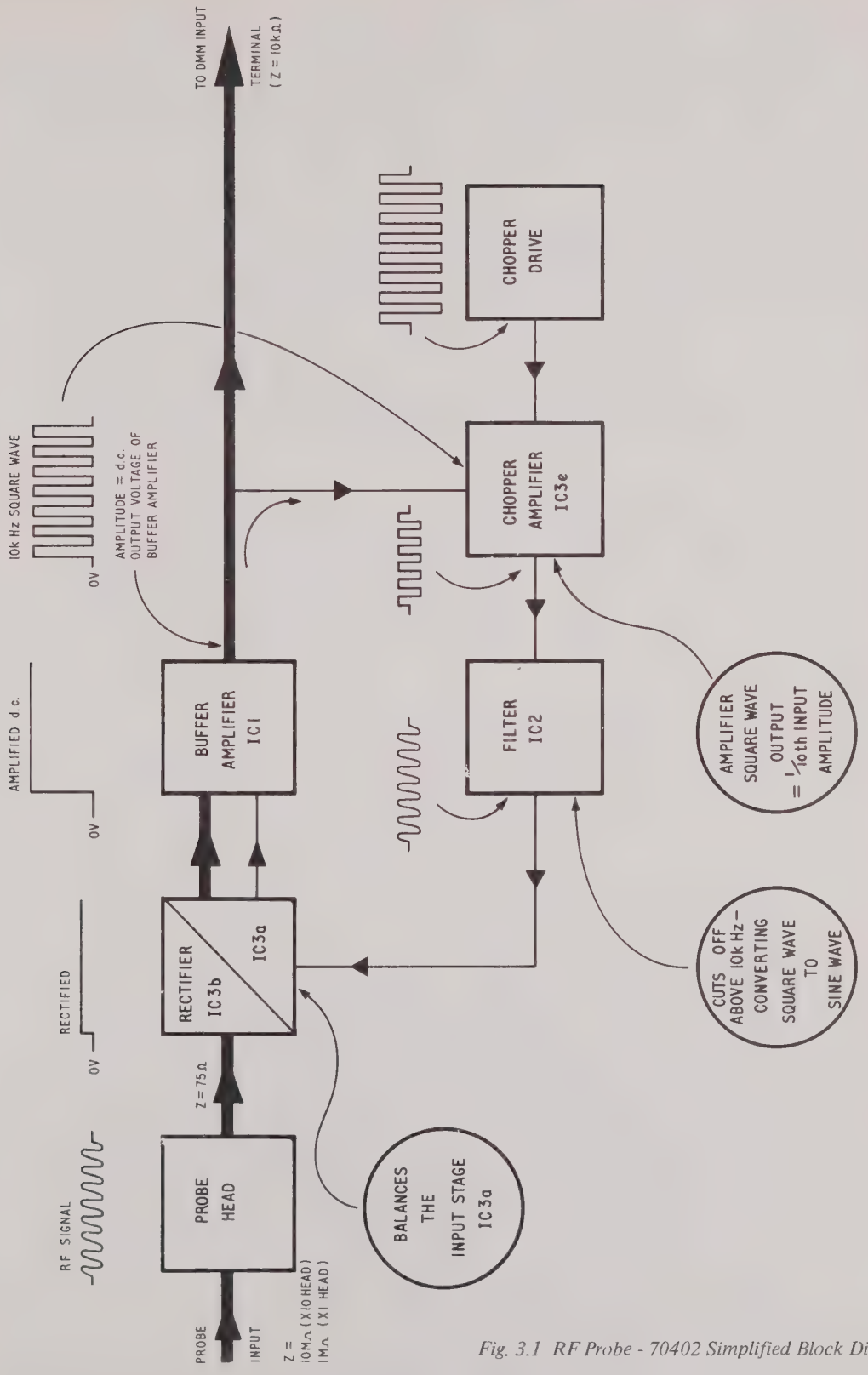


Fig. 3.1 RF Probe - 70402 Simplified Block Diagram

1.3 Thermo Converter, 0.02% Grade at 1kHz to 1.5% at 100MHz, *e.g. Hewlett Packard Model 11049A.*

1.4 Impedance Converter 50Ω to 75Ω. *See Fig. 3.5*

1.5 10kΩ, 1%, ¼W Carbon resistor · 820Ω ½W resistor

1.6 100Ω, 1%, ¼ watt carbon resistors: 2 off for 50Ω termination. *See Fig. 3.7*

1.7 Constant Amplitude Signal Generator 365kHz to 100MHz *e.g. Tektronix 191*

1.8 AC Voltage Calibrator, 0.02% grade, *e.g. HP 745A.*

1.9 DC Voltage Calibrator, 0.02% grade, *e.g. Time Electronics Calibrator Type 2003, 20mA max. output*

1.10 VHF Sweep Generator and Attenuator, 0 - 300MHz, *e.g. Marconi TF2361 with VHF Sweep Unit TM 9693 and VHF/UHF Attenuator TM 9695.*

1.11 Mains Auto Transformer, *e.g. Variac.*

1.12 Power Splitter, 3 port, 50Ω *See Fig.* 3.6

1.13 High Impedance Null detector with 1μV sensitivity *e.g. Fluke 845AB, or Julie ND 106.*

1.14 Battery DC reference. *See Fig. 3.8*

1.15 50Ω Co-Axial Texcan RF Switch.

1.16 Special 50Ω terminating sleeve *(to accom. probe tip).*

1.17 Split Probe sleeve.

2. TEST PROCEDURE

Note. In the following tests the figures in brackets apply when a X10 PROBE HEAD is fitted.

2.1 Main Unit

a) Check that the mains tapping block is set to the nominal value of the mains source. Plug in the mains input and switch on.

b) Ensure that the voltage of the ± 17V rails is within the limits 17.0 and 18.0V. Record the values.

c) Monitor the supply rails with an oscilloscope to ensure that ripple and noise amplitude does not exceed 20mV peak to peak.

d) Feed the mains input from a variable auto-transformer, varying the input voltage between the limits 190V and 260V rms for a 230V mains source, and between the limits 100V and 128V rms for a 115V mains source. Monitor both supply rails with voltmeter and oscilloscope simultaneously, verifying that the supply voltages and noise levels remain within the prescribed limits of 17V to 18V. Switch off the supply.

e) Connect the unit to nominal mains supply. Connect the oscilloscope to TP3 and adjust RV4 to obtain a square wave at a frequency of 10kHz. Check that the waveform has a 1:1 mark/space ratio and an amplitude greater than 0.5V peak to peak.

f) Check that the "POWER" LAMP is illuminated.
Break the split pad between C3 and R28 (*See Fig. 3.4*) and connect the 820Ω resistor across R28.

g) Set RV2 to mid-travel. Short-circuit the BNC input socket. Connect an oscilloscope Y input to TP4. Adjust RV1 for zero dc level.

h) Connect an oscilloscope Y input to TP5. Adjust RV3 to give minimum chopper waveform. Check that the peak-to-peak amplitude, ignoring spikes, does not exceed 5mV.

j) Connect a 7040 multimeter input to the 70402 output terminals and select the RF PROBE position on the mode switch. Rotate RV2 from end to end, ensuring that the reading on the 7040 varies from (+5.0 to 10.0mV) to (−0.1 to −0.5mV). If this condition is not satisfied adjust RV1 slightly to meet the requirement.

k) Set RV5 to mid-travel.

l) Connect a sweep generator to the BNC input socket, using a 50Ω to 75Ω impedance converter for matching purpose. Sweep from 0 to 300MHz, with an input voltage of 0.5V rms, approximately. Check that the frequency response is within ± 0.5dB to 50MHz and within ± 3dB to 300MHz. (for recommended measuring system see Figs. 3.2 and 3.3).
Bridge the split pad.

PROBE HEADS

Note 1: One each x1 and x10 probe heads are provided with each 70402 purchased.

Note 2: Figures in brackets below indicate x10 probe head, where figures for these differ from those for x1 probe head.

a) Connect the PROBE HEAD under test to a fully tested calibrated 7040 and 70402. Feed an input signal at 50kHz and of amplitude 1.0 volt (10.0 volts) rms into the probe head from the ac voltage calibrator. The 7040 should read 1.0000V. If necessary adjust RV1 within the probe head. This adjustment can be carried out by unscrewing the coller at the rear of the probe head and sliding back both coller and sleeve.

b) For the x10 Probe Head only, the trimmer may also be adjusted.

MAIN UNIT AND PROBE HEADS

a) Connect the two probe heads to the main unit in turn. Connect the ac voltage calibrator to the probe head with 1.0V (10.0V) rms input at 50kHz. Adjust RV5 on the main unit to obtain a reading of 1.0000V on the 7040. If necessary the potentiometer RV1 in the probe head may be adjusted slightly to make the probe heads interchangeable.

b) Switch the ac voltage calibrator to 0.5V (5.0V) rms output. The 7040 reading should fall within the limits 497.5 and 502.5mV.

c) Switch the ac voltage calibrator to 0.1V (1.0V) rms output. The 7040 reading should fall within the limits 97.5 and 102.5mV.

d) Connect the 70402 main unit and PROBE HEAD tip to the test equipment in accordance with Fig. 3.7. Set the coaxial switch so that the dc voltage calibrator (set to 1.0 volts output) is connected to the power splitter. Switch the Null Detector to the "ZERO 1" position and adjust for zero indication on the meter. The null detector is then set to the 30mV range, and the output of the battery-operated dc voltage source is adjusted to obtain a null. The sensitivity of the null detector should be increased progressively as a balance condition is approached. Set the null detector to the 30mV range again and then change over the coaxial switch to connect the signal generator (Tektronix 191) to the power splitter. Set the frequency to 30MHz and adjust the output voltages so that the thermo converter output is nulled against the battery dc source. Progressively increase the sensitivity of the null detector as before. When this has been completed the 7040 should read 0.5 (0.05V) +0dB −0.5dB. Refer to Response Table for the limits.

MAIN UNIT AND PROBE HEADS RESPONSE TABLE

FREQUENCY	dB	VOLTS RATIO	DMM READING LIMITS	
			x1 PROBE HEAD	x10 PROBE HEAD
30MHz	+0	1.0000	0.5000V	50.000mV
	−0.5	0.9440	0.4720V	47.200mV
100MHz	+2	1.259	0.6295V	62.950mV
	−2	0.7943	0.3971V	39.710mV
300MHz	+3	1.413	0.7065V	70.650mV
	−3	0.7080	0.3540V	35.400mV

The above figures apply for 1V Signal Generator output and 0.5V input to the Thermal Converter and 70402 PROBE HEAD.
Repeat 4 (d) at f = 100MHz. Reading should be 0.5V (0.05V) ± 2dB. Record the result.
Repeat for the other probe head.

(f) Using the test circuit of Fig. 3.9 connect each probe head in turn to the sweep generator. Sweep from 0 to 300MHz with an input Voltage of 0.5Vrms approximately. Check that the frequency response is within ± 0.5dB to 50MHz and within ± 3dB to 300MHz.

APPENDIX

Check list of control settings on sweep generator for tests.
(l) and (f):-

SWEEP WIDTH:	300MHz and WIDE
CENTRE FREQUENCY:	150MHz
SWEEP:	Linear
ALC LEVEL:	Cal
ALC OUTPUT:	−1dB
ALC:	Int.
ATTENUATOR:	Initially 0dB. Adjust as necessary.
SWEEP FUNCTION:	0.1 to 1Hz. (Note: take care that errors do not arise through sweeping too quickly. The capacity of the 70402 to follow input variations is limited. A sweep rate of 1Hz max. from 0 to 300mHz. is suitable.
BLANKING:	Off.
SWEEP MODE:	Normal
'X' DRIVE:	Reverse
RATIO:	1:1

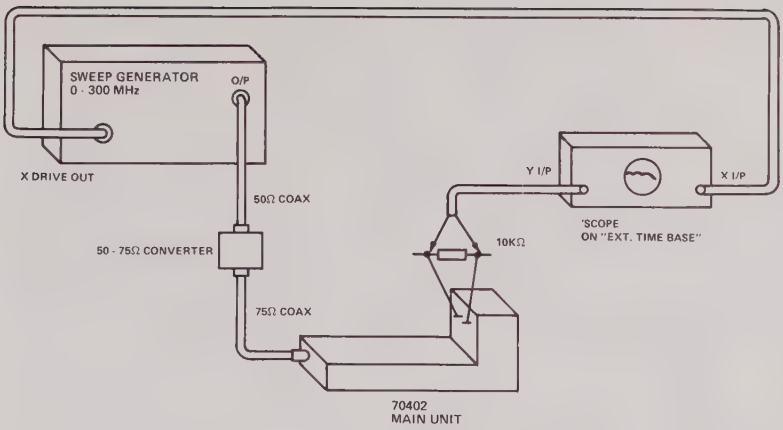


Fig. 3.2 Frequency Response Equipment

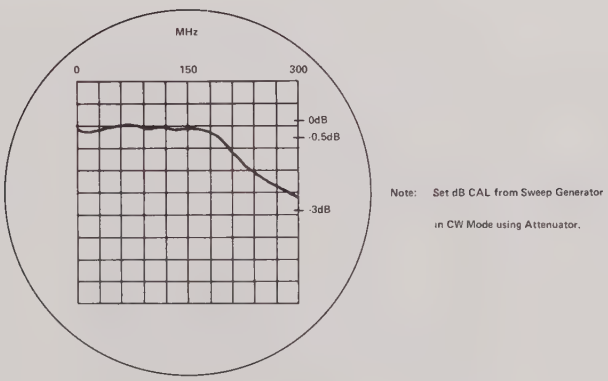


Fig. 3.3 Frequency Response Display

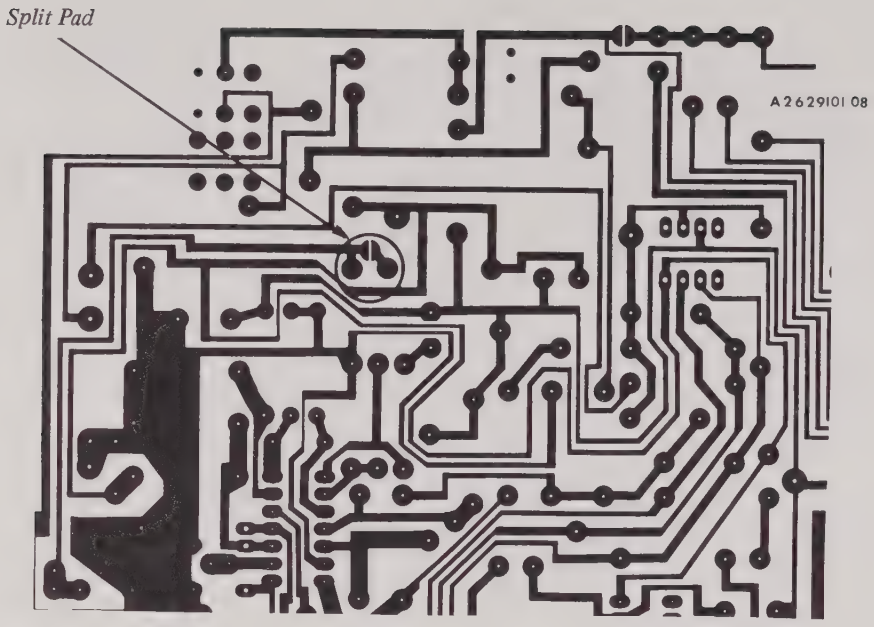
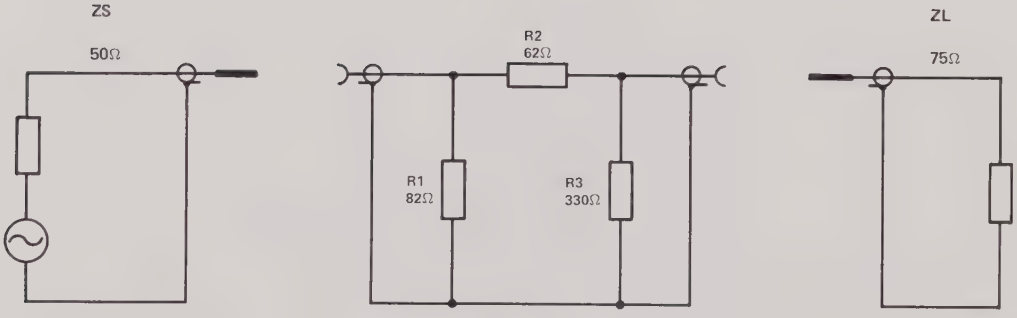


Fig. 3.4 Split Pad

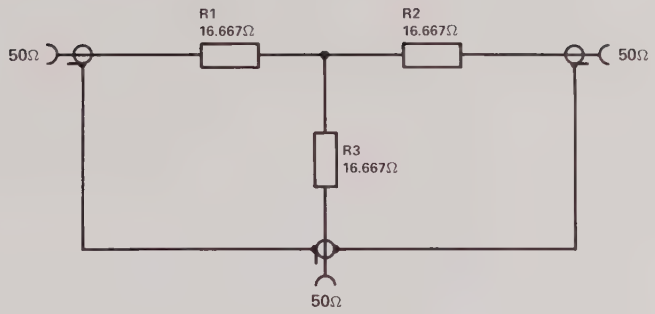


For the above preferred values ZS = 52.5Ω and ZL = 74.6Ω

For a precise value of ZS = 50Ω and ZL = 75Ω

R1 = 82.87Ω
R2 = 64.30Ω
R3 = 349.6Ω

Fig. 3.5 50-75Ω Converter



Note: R1, R2 and R3 are metal oxide resistors matched to ± 0.003%.

Fig. 3.6 Power Splitter

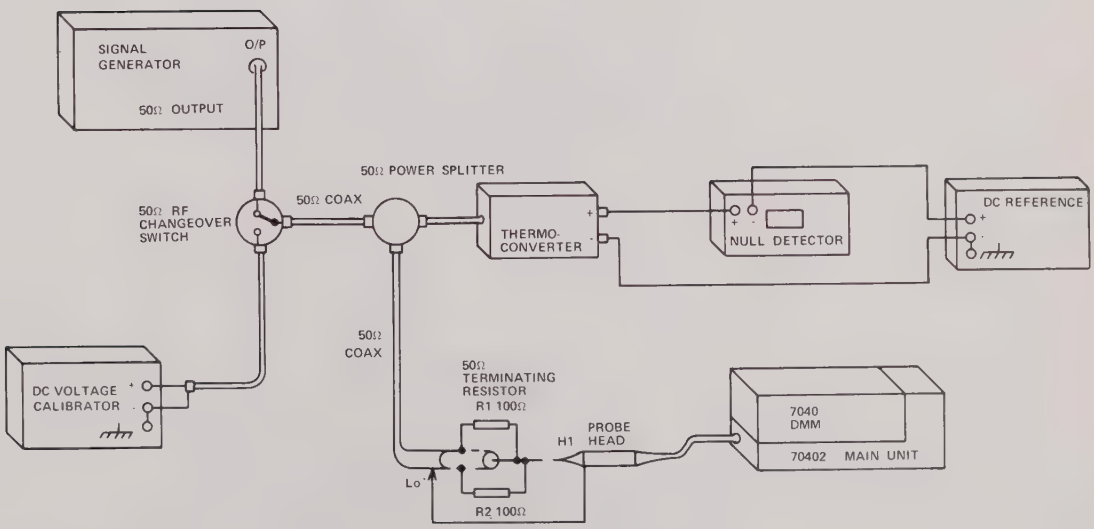


Fig. 3.7 Testing Main With Probe Heads

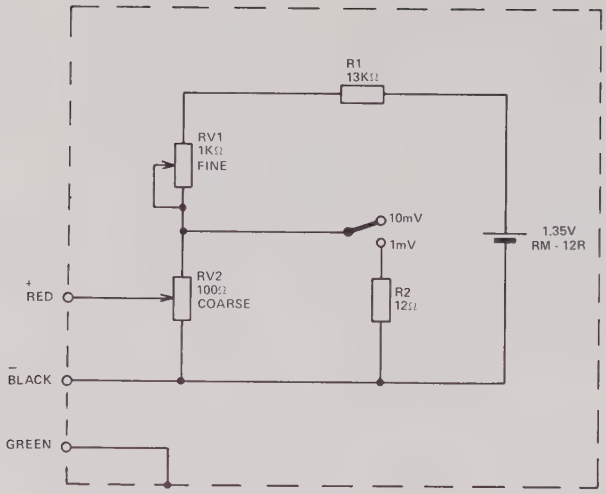


Fig. 3.8 DC Reference

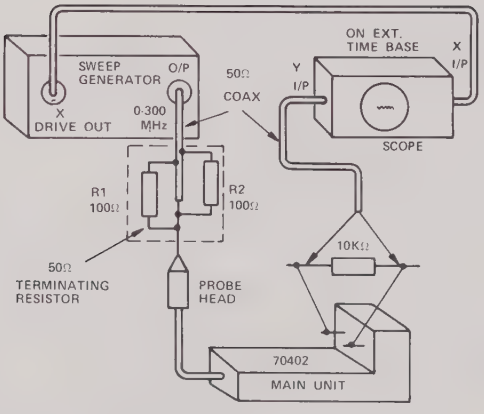


Fig. 3.9 Probe Heads Freq. Response Test Cct.

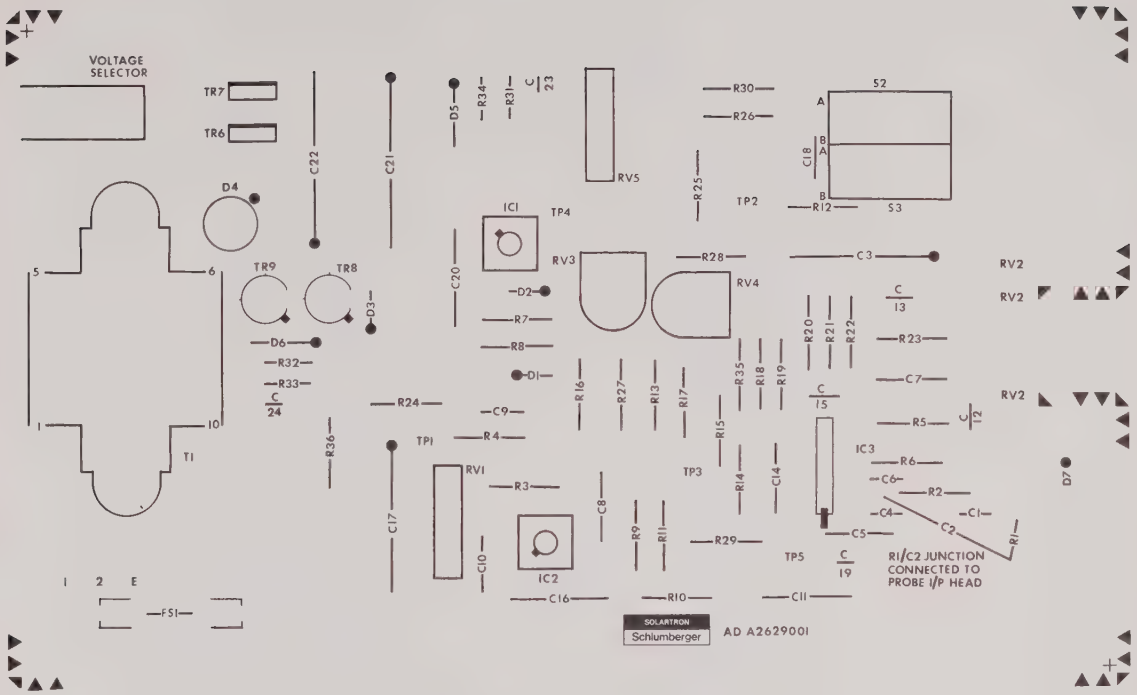


Fig. 3.10 70402 RF Probe - AC/DC Converter

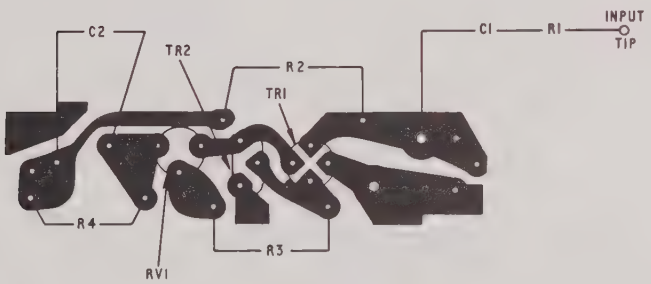


Fig. 3.11 RF Probe Head (X1)

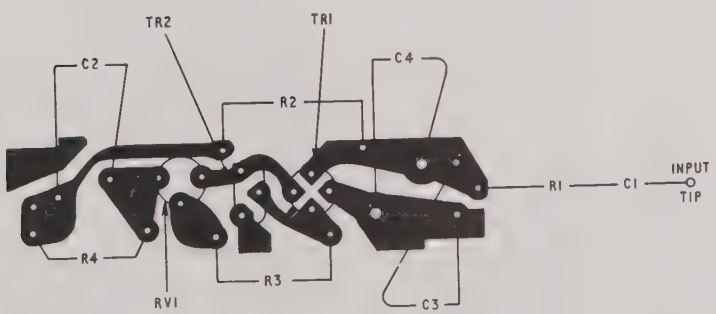


Fig. 3.12 RF Probe Head (X10)

COMPONENT PARTS LIST

ABBREVIATIONS

Circuit References

B	Battery
C	Capacitor (μF)
CSR	Thyristor
D	Diode
FS	Fuse
IC	Integrated Circuit
L	Inductor
LP	Lamp (including Neon)
LK	Link
M	Meter
MSP	Mains Selector Panel
PL	Plug
R	Resistor (Ω)
RL	Relay
S	Switch
SK	Socket
T	Transformer
TP	Terminal Post (or Test Point)
TR	Transistor
V	Valve
X	Other Components

Also Used:-

RNL	Non Linear Resistor (Ω)
RV	Variable Resistor (Ω)

Component Composition

FIXED RESISTORS

Carbon Composition	CACP
Carbon Film	CAFM
Cracked Carbon	CKCA
Metal Film	MEFM
Metal Oxide	MEOX
Power Wirewound	POWW
Precision Wirewound	PRWW
Temperature Sensitive	TEMP
Thick Film	TKFM
Thin Film	TNFM
Voltage Sensitive	VOLT

Component Composition (Cont'd)

VARIABLE RESISTORS

Wirewound Preset Single Turn	WWPS
Wirewound Preset Multiturn	WWPM
Wirewound Front Panel Single Turn	WWFS
Wirewound Front Panel Multiturn	WWFM
Carbon Preset Single Turn	CAPS
Carbon Preset Multiturn	CAPM
Carbon Front Panel Single Turn	CAFS
Carbon Front Panel Multiturn	CAFM
Cermet Preset Single Turn	CMPS
Cermet Preset Multiturn	CMPM
Cermet Front Panel Single Turn	CMFS
Cermet Front Panel Multiturn	CMFM

CAPACITORS

Air	AIR
Aluminium Electrolytic	ALME
Aluminium Solid	ALMS
Polycarbonate	CARB
Ceramic	CERM
Polyester Foil	ESTF
Polyester Metallised	ESTM
Glass	GLAS
Mica	MICA
Metallised Lacquer	MLAC
Paper Foil	PAPF
Paper Metallised	PAPM
PTFE	PTFE
Polypropylene Film	PYLN
Polystyrene	STYR
Tantalum Dry	TAND
Tantalum Foil	TANF
Tantalum Wet	TANW

Component Parts List

for

Printed Circuit Board

A2629001

(RF Probe Main Board)

Cct Ref.	General Description				Solartron Part No.
R1	MEOX	100	1/2W	1%	195421000
R2	CACP	1k	1/4W	10%	172331000
R3 to R5	MEOX	470k	1/2W	1%	195454700
R6	CACP	1k	1/4W	10%	172331000
R7	CACP	15M	1/4W	10%	172371500
R8	CACP	1M	1/4W	10%	172361000
R9	MEOX	22k	1/2W	1%	195442200
R10	MEOX	22k	1/2W	1%	195442200
R11	MEOX	27k	1/2W	1%	195442700
R12	CACP	82k	1/4W	10%	172348200
R13	CACP	4.7M	1/4W	10%	172364700
R14	CACP	10k	1/4W	10%	172341000
R15	CACP	220k	1/4W	10%	172352200
R16	MEOX	56k	1/2W	1%	195445600
R17	CACP	2.2k	1/4W	10%	172332200
R18	MEOX	22k	1/2W	5%	193542200
R19	MEOX	22k	1/2W	5%	193542200
R20	MEOX	33k	1/2W	1%	195443300
R21	MEOX	39k	1/2W	1%	195443900

Cct Ref.	General Description				Solartron Part No.
R22	MEOX	22k	1/2W	5%	193542200
R23	MEOX	22k	1/2W	5%	193542200
R24	MEOX	47	1/2W	1%	195414700
R25	CACP	330	1/4W	10%	172323300
R26	MEOX	47k	1/2W	1%	195444700
R27	CACP	4.7k	1/4W	10%	172334700
R28	CACP	270	1/4W	10%	172322700
R29	MEOX	220k	1/2W	1%	195452200
R30	CACP	10M	1/4W	10%	172371000
R31	CACP	4.7k	1/8W	10%	172034700
R32	CACP	4.7k	1/8W	10%	172034700
R33	CACP	33k	1/8W	10%	172043300
R34	CACP	10k	1/8W	10%	172041000
R35	CACP	1k	1/4W	10%	172331000
R36	CACP	1.2k	1/4W	10%	172331200
C1	CERM	0.1	30V	+50% -25%	242051000
C2	ESTM	0.22	160V	10%	220352200
C3	TAND	100	20V	20%	265881000
C4	CERM	0.1	30V	+50% -25%	242051000

Cct. Ref.	General Description				Solartron Part No.
C5	ESTM	0.47	100V	10%	225454700
C6	CERM	0.1	30V	+50% -25%	242051000
C7	ESTM	1	100V	10%	225461000
C8	ESTM	1	100V	10%	225461000
C9	ESTM	0.1	100V	10%	225451000
C10	ESTM	68p	125V	2.5%	210116800
C11	ESTM	1000p	125V	2.5%	210131000
C12	CACP	0.1	30V	+50% -25%	242051000
C13	CACP	0.1	30V	+50% -25%	242051000
C14	ESTM	0.47	100V	10%	225454700
C15	ESTM	0.022	100V	10%	225442200
C16	STYR	3300p	125V	2.5%	210133300
C17	ALME	50	25V	-20% +100%	270775000
C18	ESTM	0.1	100V	10%	225451000
C19	CERM	220p	500V	20%	241222200
C20	ESTF	1000p	400V	10%	222331000
C21	ALME	220	40V	-20% +100%	273782200
C22	ALME	220	40V	-20% +100%	273782200
C23	CERM	0.047	25V	+50% -25%	241944700
C24	CERM	0.047	25V	+50% -25%	241944700
D1 to D3	SD3				300522160
D4	Bridge Rect. WO4				300524700
D5	Zener BZY88	18V	0.4W	2%	300525040
D6	Zener BZY88	18V	0.4W	2%	300525040
D7	MV5024 Diode Light-Emitting				300750060
TR6	BD165				300555160
TR7	BD166				300555150
TR8	BC107				300553320
TR9	BCY70				300553590
IC1	Op. Amp. 741C				510000591
IC2	Op. Amp. 741C				510000591
IC3	Multiple Pack SL3045-6				300554090
RV1	CMPM	50k	3/4W	10%	130645000
RV3	CAPS	1M	1/2W	20%	137461000
RV4	CAPS	10k	1/2W	20%	137441000
RV5	CMPM	10k	3/4W	10%	130641000
T1	Mains Transformer				309602404
F1	Fuse Anti-Surge	100mA			360190120

Component Parts List

for

Printed Circuit Board

A2629002

(RF Probe Head X1)

Cct Ref.	General Description				Solartron Part No.
R1	CACP	68	1/8W	10%	172016800
R2	CACP	4.7M	1/8W	10%	172064700
R3	MEOX	470	1/4W	5%	195624700
R3A	MEOX	270	¼W	5%	195622700
R4	MEOX	51	1/4W	5%	195615100
C1	STYR	47p	500V	10%	210514700
C2	CERM	15p	200V	10%	208400057
TR1	Selected fet				300400501
TR2	ZTX325				300555190
RV1	CMFS	20	3/4W	10%	130412000

Component Parts List

for

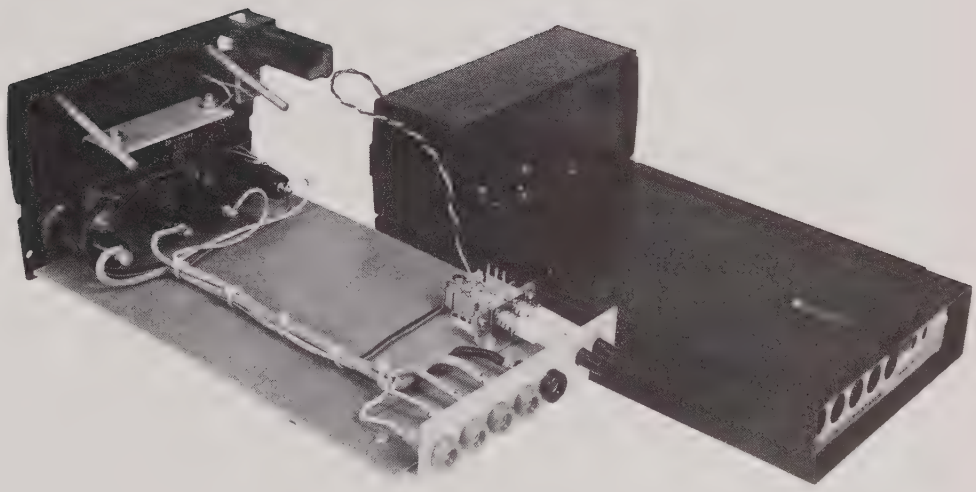
Printed Circuit Board

A2629004

(RF Probe Head X10)

Cct Ref.	General Description				Solartron Part No.
R1	CACP	10	1/8W	10%	172011000
R2	CACP	4.7M	1/8W	10%	172064700
R3	MEOX	51	1/4W	5%	195624700
R4	MEOX	51	1/4W	5%	195615100
R3A	MEOX	270	¼W	5%	195622700
C1	CERM	4.7p	200V	0.5p	240604700
C2	CERM	15p	200V	10%	208400057
C3	CERM	33p	200V	10%	208400035
C4	CERM	3.5-20p	100V		290020510
TR1	Selected fet				300400501
TR2	ZTX325				300555190
RV1	CMFS	20	3/4W	10%	130412000

SECTION 4 70403 Current Shunt



INTRODUCTION

This unit consists of current shunts which extend the current measurement capability of the DMM from 1mA to 10A, with the additional facility of AC current capability from 40Hz to 1kHz.

DC Current is measured on DC Volts mode.
AC Current is measured on AC Volts mode.

PRELIMINARY CHECKS

(1) Check the presence and value of the 4 input current fuses fitted in screw holders located on the back panel:

Range	Fuse	
10mA	100mA	SLO BLO
100mA	500mA	SLO BLO
1A	2A	SLO BLO
10A	10A	SLO BLO

Ensure that the 10A fuse is clean and fitted securely in the holder. Set the DMM to OFF and fit the DMM to the 70403 CURRENT SHUNT as detailed in "ACCESSORY FITTING INSTRUCTIONS".

OPERATION

(1) Plug the mains lead firmly into the CURRENT SHUNT and apply a mains input.

(2) Select "VDC" on the DMM and "Sub Unit" on the CURRENT SHUNT.

(3) Apply the unknown dc current (⊅ 10A) in series with the COMMON SOCKET and 10A socket. Note the DMM reading.
Current value = (DMM reading (mV) x100) mA.

(4) Select a current range giving the resolutions required.
Caution
To ensure that the current shunts are not damaged due to overload the DMM reading must not exceed 110mV.

(5) Determine the exact value of the current being measured by noting the DMM reading and multiplying this by the factors shown in Table 1.

TABLE 1

Range	Reading	Representing	Example
10mA	mV	mA x 10	24.06mV = 2.406mA
100mA	mV	mA	24.06mV = 24.06mA
1A	mV	mA ÷ 10	24.06mV = 240.6mA
10A	mV	mA ÷ 100	24.06mV = 2.406A

(6) AC Currents between 40Hz and 1kHz may also be measured. In this case, repeat paras. (2) to (5) above, selecting "VAC".

SPECIFICATION

ENVIRONMENT

Working Temperature Range : 0 to +45°C

Storage Temperature Range : −30 to 70°C

Maximum Relative Humidity : 70% at 40°C

RANGES

Range	Resolution	Shunt Resistance	Volts Drop (Max.)
10mA	1μA	10Ω	300mV
100mA	10μA	1Ω	
1A	100μA	0.1Ω	
10A	1mA	0.01Ω	

ACCURACY For 90 Days, Basic 7040 Included.

DC Range	Accuracy	Temperature Coefficient
10mA, 100mA	± 0.1% reading ± 0.05% range	± 100ppm/°C
1A	± 0.25% of reading ± 0.05% of range	± 100ppm/°C
10A	± 0.4% of reading ± 0.05% of range	± 100ppm/°C

AC RANGE

(40Hz to 1kHz)

10mA, 100mA	± 0.1% of reading ± 0.1% of range	± 160ppm/°C
1A, 10A	± 0.4% of reading ± 0.1% of range	± 160ppm/°C

DIMENSIONS

Width	: 130mm (5.12 in)
Height *(Front Panel)*	: 32mm (1.25 in)
Height *(Back Panel)*	: 89mm (3.5 in)
Length	: 228mm (9 in)
Weight	: 0.8kg (17.6lb)

OVERLOAD PROTECTION

Range	Fuse	Part No.
10mA	100mA	360103030
100mA	500mA	360103060
1A	2A	360103100
10A	10A	360103150

TECHNICAL DESCRIPTION

This unit consists of a fixed resistance through which the unknown input current flows. The potential drop across the resistance is measured by the DMM.

CAUTION: Ensure that F1 (10A) is clean and makes good electrical connections.

70403 TEST PROCEDURE

ENVIRONMENT

The ambient temperature should be between 20° and 25°C. The relative humidity should be between 40% and 60% at the ambient temperature.

1. TEST EQUIPMENT

(a) Multimeter *e.g. Solartron 7040.*

(b) Set of four shunt standard resistors of nominal values 0.01Ω, 0.1Ω, 1Ω and 10Ω whose accuracy is known to 0.25%, 0.25%, 0.1% and 0.1% respectively. Power rating: 1 Watt.

(c) Source of constant current, adjustable, giving 10mA, 100mA, 1A and a current above 1A in the range 5-10A. The stability of the source, over a period of one minute, should be better than 0.01% at 10mA and 100mA and 0.025% at 1A and above.

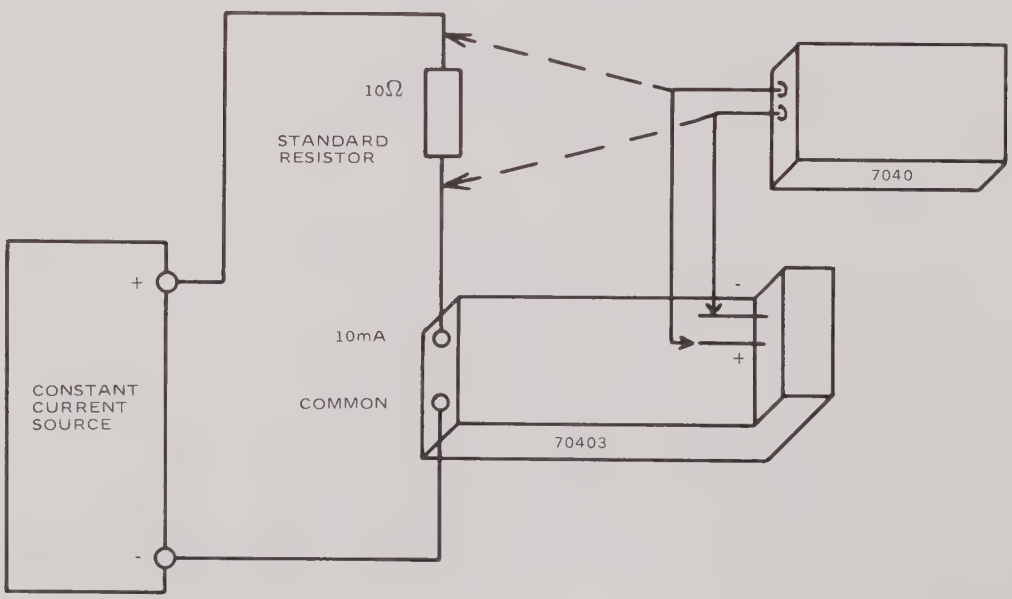
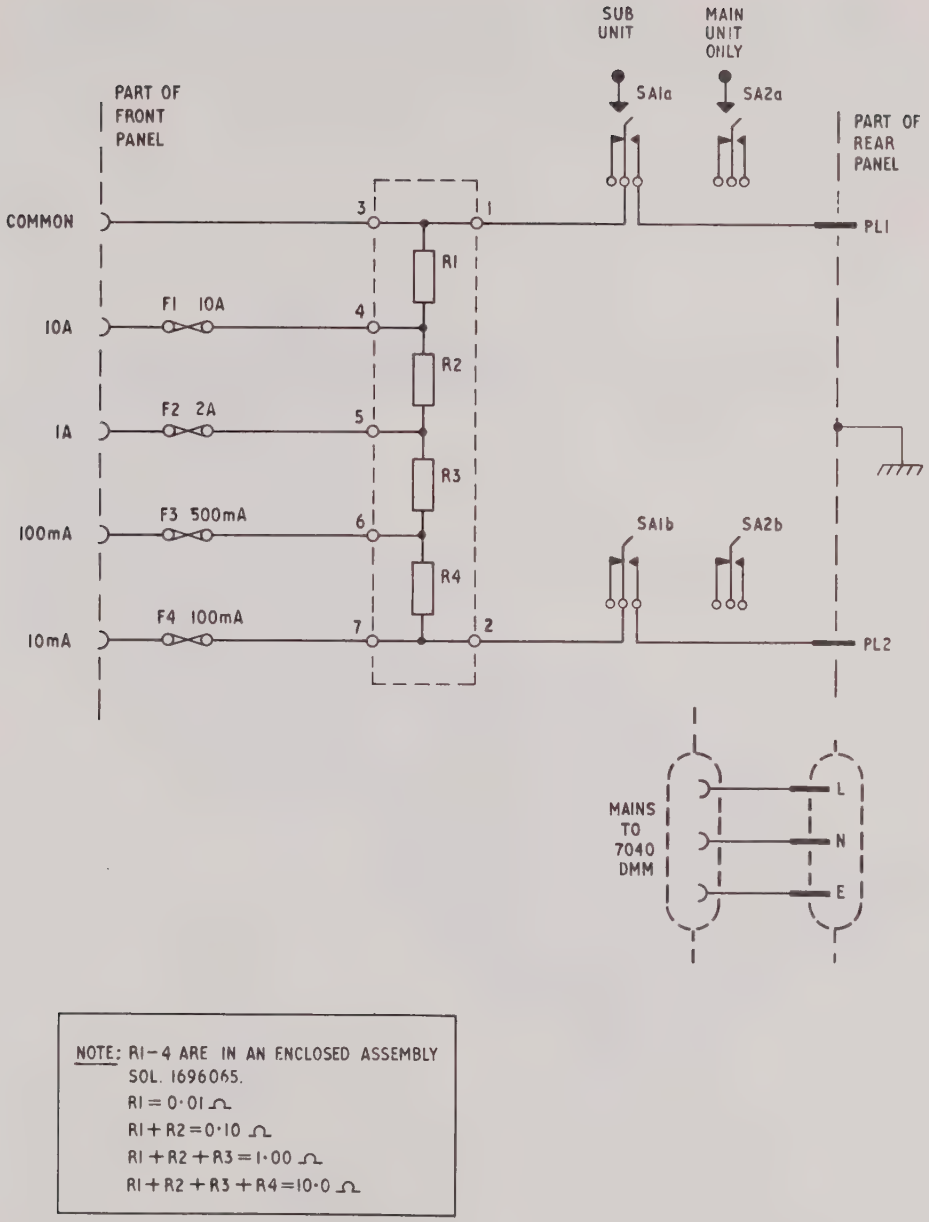


Fig. 4.1 70403 Test Circuit showing 10Ω standard resistor connected to the 10mA terminal.

2. TEST PROCEDURE

(a) The test equipment is connected as in Fig. 4.1 above. The 70403 "sub-unit" button is depressed and the input leads are connected to "10mA" and "Common". The constant current source is slowly increased to provide a current such that the drop across the 10Ω standard resistor is (10 x R)mV, where R is the actual measured value of the resistor. The leads of the 7040 are transferred to the 70403 output terminals on the plug plate, observing polarity. Check that the 7040 reads + (10 x R)mV ± 0.1%.



NOTE: R1–4 ARE IN AN ENCLOSED ASSEMBLY SOL. 1696065.
R1 = 0·01 Ω
R1 + R2 = 0·10 Ω
R1 + R2 + R3 = 1·00 Ω
R1 + R2 + R3 + R4 = 10·0 Ω

Fig. 4.2 Current Shunt Circuit Diagram A2637001

(b) Connect the 70403 leads to "100mA" and "Common". Replace the 10Ω standard with the 1Ω standard. Slowly increase the constant current source to give a current through the 1Ω resistor such that the voltage drop across the resistor is (100 x R)mV. The leads of the 7040 are then transferred to the 70403 output, observing polarity. Check that the 7040 reads + 100mV ± 0.1%.

(c) Connect the 70403 leads to "1A" and "Common". Insert the 0.1Ω resistor in place of the 1Ω resistor. Slowly increase the constant current source to give a current through the 0.1Ω resistor such that the voltage drop across the resistor is (1000 x R)mV. The leads of the 7040 are transferred to the 70403 output, observing polarity. Check that the 7040 reads +100mV ± 0.25%.

(d) Connect the 70403 leads to "1A" and "Common". Insert the 0.01Ω nominal resistor in place of the 0.1Ω resistor. Slowly increase the constant current source to give a current through the 0.01 resistor such that the voltage drop across the resistor is (10000 x R)mV. The leads of the 7040 are transferred to the 70403 output, observing polarity. Check that the 7040 reads +100mV* ± 0.4%.

(e) Check that the "main unit" push button, when depressed isolates the 70403 output terminals from the remainder of the unit completely.

*Scale the results according to the constant current supply. For example for a 5A current the voltage drop is (5000 x R)mV and the 7040 reading should be +50.00mV ± 20 digits.

Component Part List

for

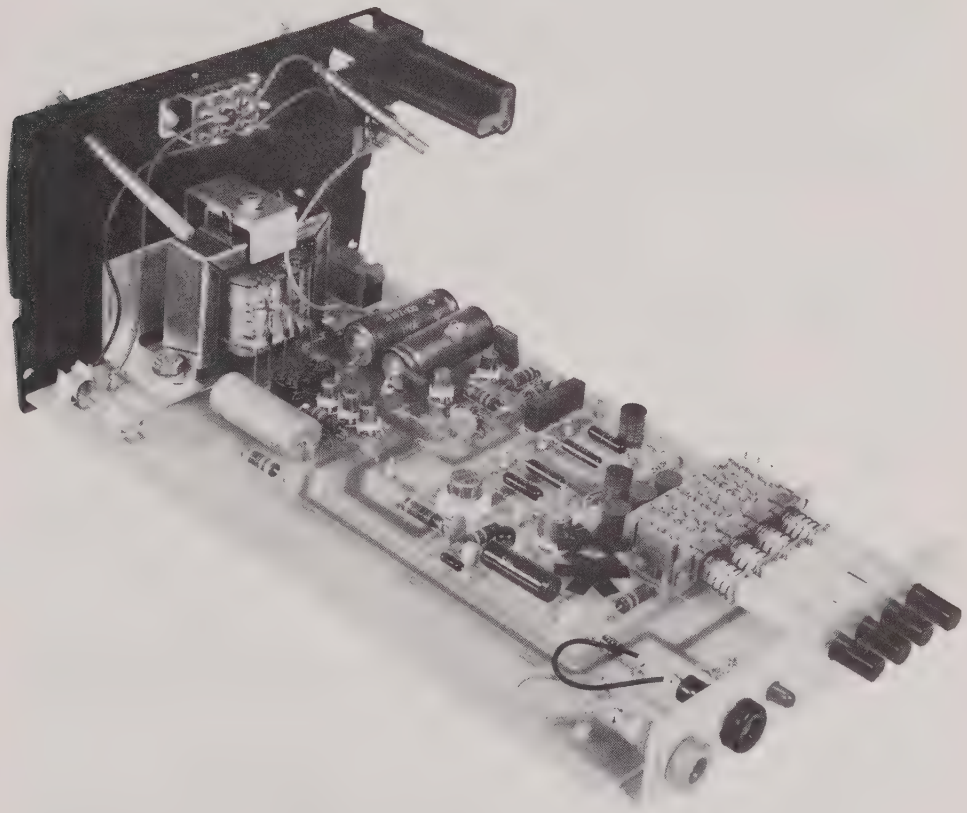
Printed Circuit Board

A2630012

(Current Shunt)

Cct Ref.	General Description	Solartron Part No.
R1 to R4	Assembly	169606503
FS1	10A	360103150
FS2	2A	360103100
FS3	500mA	360103060
FS4	100mA	360103030

SECTION 5 70404 Low Level Resistance Unit



INTRODUCTION

When fitted to the DMM, this unit provides 3 additional resistance ranges of 1Ω, 10Ω and 100Ω (full scale with 10% over range). The DMM reads "mV" or "V".

On the 100Ω range, there is also 1kΩ measurement capability due to the DMM Auto Range facility.

The 4 terminal measurement technique is used which is essential for accurate resistance measurement with 100μΩ resolution.

PRELIMINARY CHECKS

(1) Check that the voltage selection indicator is set to the correct mains supply voltage as indicated by the red marker on the back panel.

(2) Should this require resetting proceed as follows:

(a) remove the two case securing screws on the lower corners of the back panel;

(b) slide the outer case off;

(c) slacken the three mains transformer (T1) securing screws so that the voltage selector (red block) can be repositioned and the red marker fitted to the back panel window to indicate the correct mains voltage;

(d) check the presence and value of the mains fuse located in the open fuse holder on the printed circuit board;

100mA SLO BLO Part No. 360190120

(e) tighten T1 securing screws and replace the case and the case securing screws.

(3) Set the DMM to OFF and fit the DMM to the 70404 LOW LEVEL RESISTANCE UNIT as detailed in "ACCESSORY FITTING INSTRUCTIONS".

OPERATION

(1) Plug in the mains lead firmly to the LOW LEVEL RESISTANCE UNIT and apply a mains input.

(2) The mains ON/OFF switch (SUB UNIT POWER) for the LOW LEVEL RESISTANCE UNIT is located on the back panel and operates independently of the DMM switch. Set the ON/OFF switch to ON.

(3) Select "VDC" on the DMM.

(4) Connect the two pairs of test probes to the DMM and the RESISTANCE UNIT and apply these to the unknown resistance (Rx) as shown in Fig. 5.1.

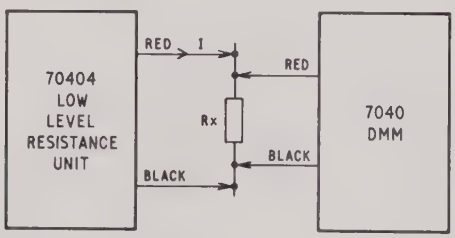


Fig. 5.1 Lead Connections. 4 Terminal Resistance Measurement.

(5) Select an appropriate resistance range on the RESISTANCE UNIT front panel bush buttons.

(6) Note the DMM reading and determine the value of the unknown resistance from Table 5.1.

TABLE 5.1

Range	Reading	Representing	Example
1Ω	mV	Ω x 100	24.06mV = 0.2406Ω
10Ω	mV	Ω x 10	24.06mV = 2.406Ω
100Ω	mV	Ω	24.06mV = 24.06Ω
	or V	kΩ	0.2406V = 240.6Ω

SPECIFICATION

ENVIRONMENT

Working Temperature Range : 0 to 45°C

Storage Temperature Range : –30 to +70°C

Maximum Relative Humidity : 70% at 40°C

POWER SUPPLY

Voltage : 117/234V +10%, –15%

Frequency : 50/60Hz ± 2%

Consumption : 4VA

Fuse : 100mA SLO BLO
Part No. 360190120

RANGES

Range	Resolution	Current	Volts Drop (Max.)
1Ω	100μΩ	100mA	100mV
10Ω	1mΩ	10mA	100mV
100Ω	10mΩ	1mA	100mV
1kΩ	100mΩ	1mA	1V

Temperature Coefficient $< \pm$ 100ppm/°C

ACCURACY For 90 days, Basic 7040 Included

For all ranges: ± 0.1% of reading
± 0.05% of range

These limits of error (uncertainty) will hold for 90 days after calibration, for measurements made at the calibration temperature.

PROTECTION

Maximum Input (peak) : 200V

DIMENSIONS

Width	:	130mm (5.12 in)
Height *(Front Panel)*	:	32mm (1.25 in)
Height *(Back Panel)*	:	89mm (3.5 in)
Length	:	228mm (9 in)
Weight	:	0.9kg (2lb)

ACCESSORIES

		Part No.
Test Probe Red	:	351901040
Test Probe Black	:	351901030
Crocodile Clips (2 off)	:	355900150

TECHNICAL DESCRIPTION

The following circuit descriptions refer to the adjacent block circuit diagram, each coloured area of which corresponds to each of the following sub-headings.

± 17V STABILISED SUPPLY

Two conventional series regulated power supplies each fed from a common full wave bridge rectifier D6.

As the zener current for each supply is normally derived from the other rail, it would be possible that neither rail would stabilise on switch-on. R18, R21 and D7 provide a by-pass path to ensure that the +17V rail stabilises on switch-on which in turn will enable the −17V rail to stabilise.

+6V SUPPLY AND INDICATOR

An unregulated supply to drive the sensing current used to measure the unknown resistance via the front panel socket HiΩ (RED). This output rises to 7-9V off load.

REFERENCE VOLTAGE

The stabilised output at TR4 (6.2V) is divided down by the chain R1-8. RV1 is set for 1.0000V at TP3.

CURRENT CONTROL

The high impedance differential amplifier IC1 output sets a voltage at the gate of TR1 such that a constant current is produced from the +6V rail to 0V and the voltage at IC1-pin 2 always equals the reference voltage at IC1-pin 3.

CURRENT SELECTION

The values of R12, R13 and R14 are such that the currents of 100mA, 10mA and 1mA respectively will develope a pd of 1V which is fed back to the amplifier input via R22.

On all ranges, the constant current from CURRENT CONTROL is set so that the voltage at the junction of the feedback resistor R22 and SB1b is 1.0000V ± 0.05% maximum between selected ranges.

POSITIVE VOLTAGE PROTECTION

If a positive voltage greater than 15V is applied to the LoΩ (BLACK) socket with respect to the HiΩ (RED) socket, TR4, TR5 and TR6 turn on thus effectively shorting the reference zener voltage (+6.2V) developed by D1 to 0V. Maximum permitted input voltage is +200V.

NEGATIVE VOLTAGE PROTECTION

The current drawn from the source is 250μA maximum with −200V applied to the input sockets.

NOTES

1 ALL COMPONENTS SHOWN ON THIS DIAGRAM ARE MOUNTED ON P.C.B. A2649301.

2 SELECTOR SB IS MECHANICALLY INTERLOCKED

3 —◖◗— INDICATES A SOLDER PAD LINK

POSITIVE VOLTAGE PROTECTION

D2 IN3595
+6V
TR4 BCY70
TR5 BC107
TR6 BC107
R15 100k
R17 10k
TP4
0V

REFERENCE VOLTAGE

+17V
R1 1·5k
R2 10·5k
R3 1·2k
R4 620
R5 330.
R6 180
R8 2·2k
LK1
LK2
LK3
LK4
D1 IN3497 6·2V
RV1 200
SET VOLTS
TP3
0V

CHECK TP3 FOR 1·0000V

BOARD No. A2649301
PART OF FRONT PANEL
+6V
Hi
Lo
HiΩ
LoΩ
TEST TERMINALS

NEGATIVE VOLTAGE PROTECTION
D3 IN4004

CURRENT CONTROL

D10 SD3
+17V
IC1 μ741C
TP6
C6 220p
R9 10k
R10 15k
TR1 U1899
TR2 40327
TR3 40327
R11 22k
R22 1k
-17V
TP5

+6V SUPPLY AND INDICATOR

D5 W04
C3 1000
R16 470
D4 MV5024
PANEL LIGHT
0V
+6V

SUB UNIT POWER

PART OF REAR PANEL
OFF ON
BOARD No. A2649301
SA1
SA2
FS1 100mA
VOLTAGE SELECTOR *
T1 3096024
MAINS SUPPLY 115/230V 50/60Hz
L
N
E
0V

* CONTINUOUS LINE INDICATES LINK FOR 230V OPERATION
BROKEN LINE INDICATES 115V CONNECTIONS

±17V STABILISED SUPPLY

D6 W04
C4 220
C5 220
TR9 BD166
TR7 BC107
TR8 BC179
TR10 BD165
R19 4·7k
R20 4·7k
D8 18V
D9 18V
D7 SD3
R18 10k
R21 33k
C1 0·047
C2 0·047
TP1
TP2
+17V
-17V

CURRENT SELECTION

MAIN UNIT ONLY SB4b
RANGE
100Ω=mV SB3b
10Ω=mV/10 SB2b
1Ω=mV/100 SB1b
SB4a
SB3a
SB2a
SB1a
R14 1k
R13 100
R12 10
0V

MAINS TO 7040 DMM
L
N
E

BOARD No A2649301

Fig. 5.2 Low-Level Resistance Unit A2647001

D. A2647001

70404 TEST PROCEDURE

ENVIRONMENT

The ambient temperature should be between 20°C and 25°C. The relative humity should be between 40% and 60% at the ambient temperature.

1. TEST EQUIPMENT

(a) Oscilloscope, with 10mV/cm sensitivity *e.g. SOLARTRON A100.*

(b) Digital Multimeter *e.g. SOLARTRON 7040.*

(c) Mains Auto Transformer, *e.g. Variac.*

(d) DC power supply with output variable between 0V and 200V.

(e) Precision resistors as detailed below. These should be four-terminal resistors and, although their values are not critical, their accuracy should be known within the limits specified:-

a) 1Ω nominal ± .01%

b) 10Ω nominal ± .01%

c) 100Ω nominal ± .01%

2. TEST PROCEDURE

(a) Check that the mains tapping block is set to the nominal value of the mains plug in the mains input and switches on.

(b) Check that "POWER" LAMP is illuminated.

(c) Ensure that the voltage of both ± 17V rails is within the limits 17.0 and 18.0 volts. The 6V rail is to be within the limits 7-0 and 9-0 volts, measured on Hi socket.

(d) Monitor the supply rails with an oscilloscope, and check that ripple and noise do not exceed 20mV peak-to-peak.

(e) Feed the mains input from a variable auto-transformer, varying the input voltage between the limits 190V and 260V rms for 230V mains source and between 100V and 128V rms for a 115V mains source. Monitor both supply rails with voltmeter and oscilloscope simultaneously, verifying that the supply voltages and ripple levels remain within the precribed limits of 17V to 18V. Switch off the supply.

(f) Adjust RV1 to obtain a reading of +1.0000V on TP3. If this cannot be achieved remove links LK1, 2, 3, 4, as required, to obtain this result.

(g) Short circuit the test sockets Hi and Lo and press the three range selection buttons in turn while monitoring junction R22/SB16. The voltage should be adjusted, by means of RV1, so that the voltage on this point is +1.0000V with a maximum variation between switch positions of ± 0.05%.

(h) Monitor TP4 and select 1Ω/mV range. Connect the dc supply across the RED (Hi) and BLACK (Lo) test terminals, with the Lo terminal positive. Gradually increase the supply voltage and ensure that the reference voltage disappears before the supply output reaches 15V. Continue to raise the voltage to an upper limit of 200V. Check that the reference voltage does not re-appear until the 200V supply is removed.

(j) With Ω = mV ge selected connect the d pply across the RED (Hi) and BLACK (Lo) test termina he Lo terminal nega s the voltage of the supply is raised gradually to a maxim f +200V-chec current drawn from the supply does not exceed 250μA.

(k) Connect the resistors of 100Ω (nominal) across the Hi and Lo test terminals of the 70404 and connect the DMM across the voltage terminals of the resistor, with the mode switch at VDC. The reading on the 7040 should be the resistance of the 100Ω resistor ± 0.1% ± 1 digit.

(l) Select the 0.1Ω/mV range. Connect the resistor of 10Ω (nominal) across the Hi and Lo test terminals of the 70404 and connect the DMM across the voltage terminals of the resistor. The reading on the DMM should be resistance of the 10Ω resistor ± 0.1% ± 1 bit.

(m) Select the 0.01Ω/mV range. Connect the resistor of 1Ω (nominal) across the Hi and Lo test terminals of the 70404 and connect the DMM across the voltage terminals of the resistor. The reading on the DMM should be the resistance of the 1Ω resistor ± 0.1% ± 1 bit.
Note: If k), l) and m) conditions cannot be met then it may be necessary to re-adjust RV1 slightly to obtain this condition.

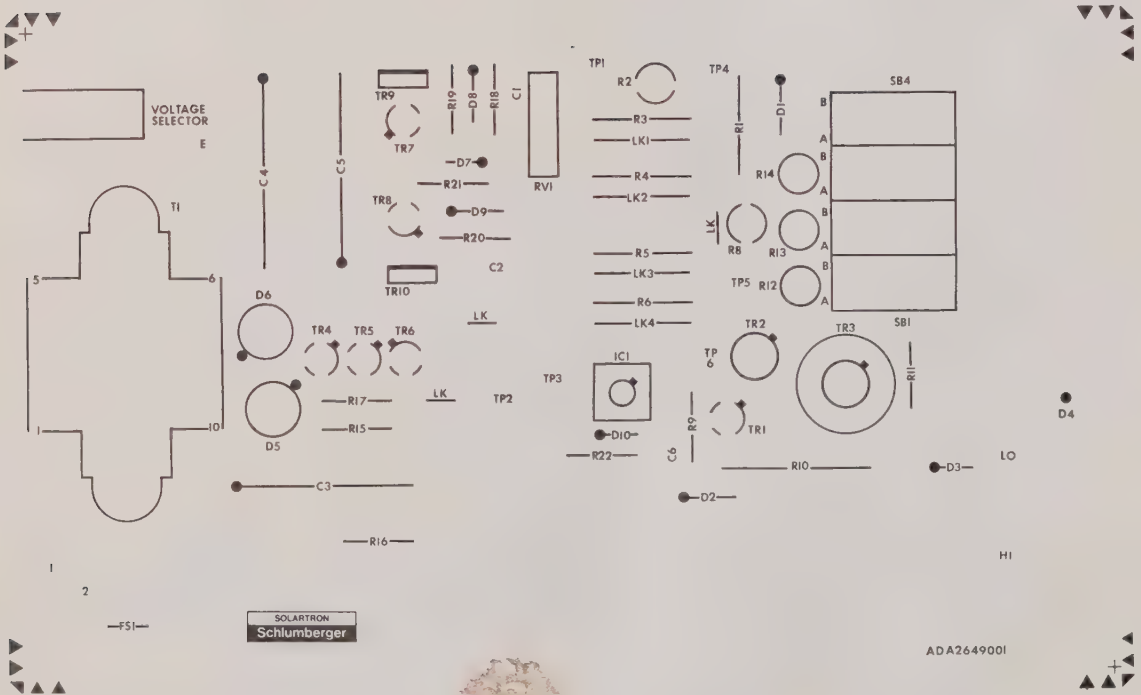


Fig. 5.3 70404 Low-Level Resistance Unit

COMPONENT PARTS LIST

ABBREVIATIONS

Circuit References

B	Battery
C	Capacitor (μF)
CSR	Thyristor
D	Diode
FS	Fuse
IC	Integrated Circuit
L	Inductor
LP	Lamp (including Neon)
LK	Link
M	Meter
MSP	Mains Selector Panel
PL	Plug
R	Resistor (Ω)
RL	Relay
S	Switch
SK	Socket
T	Transformer
TP	Terminal Post (or Test Point)
TR	Transistor
V	Valve
X	Other Components

Also Used:-

RNL	Non Linear Resistor (Ω)
RV	Variable Resistor (Ω)

Component Composition

FIXED RESISTORS

Carbon Composition	CACP
Carbon Film	CAFM
Cracked Carbon	CKCA
Metal Film	MEFM
Metal Oxide	MEOX
Power Wirewound	POWW
Precision Wirewound	PRWW
Temperature Sensitive	TEMP
Thick Film	TKFM
Thin Film	TNFM
Voltage Sensitive	VOLT

Component Composition (Cont'd)

VARIABLE RESISTORS

Wirewound Preset Single Turn	WWPS
Wirewound Preset Multiturn	WWPM
Wirewound Front Panel Single Turn	WWFS
Wirewound Front Panel Multiturn	WWFM
Carbon Preset Single Turn	CAPS
Carbon Preset Multiturn	CAPM
Carbon Front Panel Single Turn	CAFS
Carbon Front Panel Multiturn	CAFM
Cermet Preset Single Turn	CMPS
Cermet Preset Multiturn	CMPM
Cermet Front Panel Single Turn	CMFS
Cermet Front Panel Multiturn	CMFM

CAPACITORS

Air	AIR
Aluminium Electrolytic	ALME
Aluminium Solid	ALMS
Polycarbonate	CARB
Ceramic	CERM
Polyester Foil	ESTF
Polyester Metallised	ESTM
Glass	GLAS
Mica	MICA
Metallised Lacquer	MLAC
Paper Foil	PAPF
Paper Metallised	PAPM
PTFE	PTFE
Polypropylene Film	PYLN
Polystyrene	STYR
Tantalum Dry	TAND
Tantalum Foil	TANF
Tantalum Wet	TANW

Component Parts List for Printed Circuit Board A2649001 (Low Level Resistance Unit)

Cct Ref.	General Description				Solartron Part No.
R1	MEFM	1.5k	1/4W	1%	198331502
R2	PRWW	10.5k	1/10W	1%	160300402
R3	MEFM	1.2k	1/4W	1%	198331202
R4	MEFM	620	1/4W	1%	198326292
R5	MEFM	330	1/4W	1%	198323302
R6	MEFM	180	1/4W	1%	198321802
R8	PRWW	2.2k	1/10W	1%	160300403
R9	CACP	10k	1/4W	10%	172341000
R10	POWW	15k	3W	5%	173741500
R11	CACP	22k	1/4W	10%	172342200
R12	PRWW	10	1/4W	0.05%	160300404
R13	PRWW	100	1/4W	0.05%	160300405
R14	PRWW	1k	1/4W	0.05%	160300406
R15	CACP	100k	1/4W	10%	172351000
R16	CACP	470	1/4W	10%	172324700
R17	CACP	10k	1/4W	10%	172324700
R18	CACP	10k	1/4W	10%	172341000
R19	CACP	4.7k	1/4W	10%	172334700
R20	CACP	4.7k	1/4W	10%	172334700
R21	CACP	33k	1/4W	10%	172343300
R22	CACP	1k	1/4W	0%	172331000
RV1	CMPM	200	3/4W		130622000
C1	CERM	0.047	25V		[illegible]
C2	CERM	0.047	25V	-20	24194[illegible]
C3	ALME	1000	10V	-20% +100%	273191 [illegible]0
C4	ALME	220	40V	-20% +100%	273782200

Cct. Ref.	General Description				Solartron Part No.
C5	ALME	220	40V	-20% +100%	273782200
C6	CERM	220p	500V	20%	241322200
D1	Zener IN3497				300522800
D2	IN3595				300523590
D3	IN4004				300522070
D4	MV 5024 Diode Light-Emitting				300750060
D5	Bridge Rectifier W04				300524700
D6	Bridge Rectifier W04				300524700
D7	SD3				300522160
D8	Zener	18v	0.4W	2%	300525040
D9	Zener BZY88	18V	0.4W	2%	300525040
D10	SD3				300522160
TR1	F.E.T. U1899				300554320
TR2	40327				300552890
TR3	40327				300552890
TR4	BCY70				300553590
TR5	BC107				300553320
TR6	BC 107				300553320
TR7	BC107				
TR8	BC107				300553320
	BCY70				300553590
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	[illegible]				510000591
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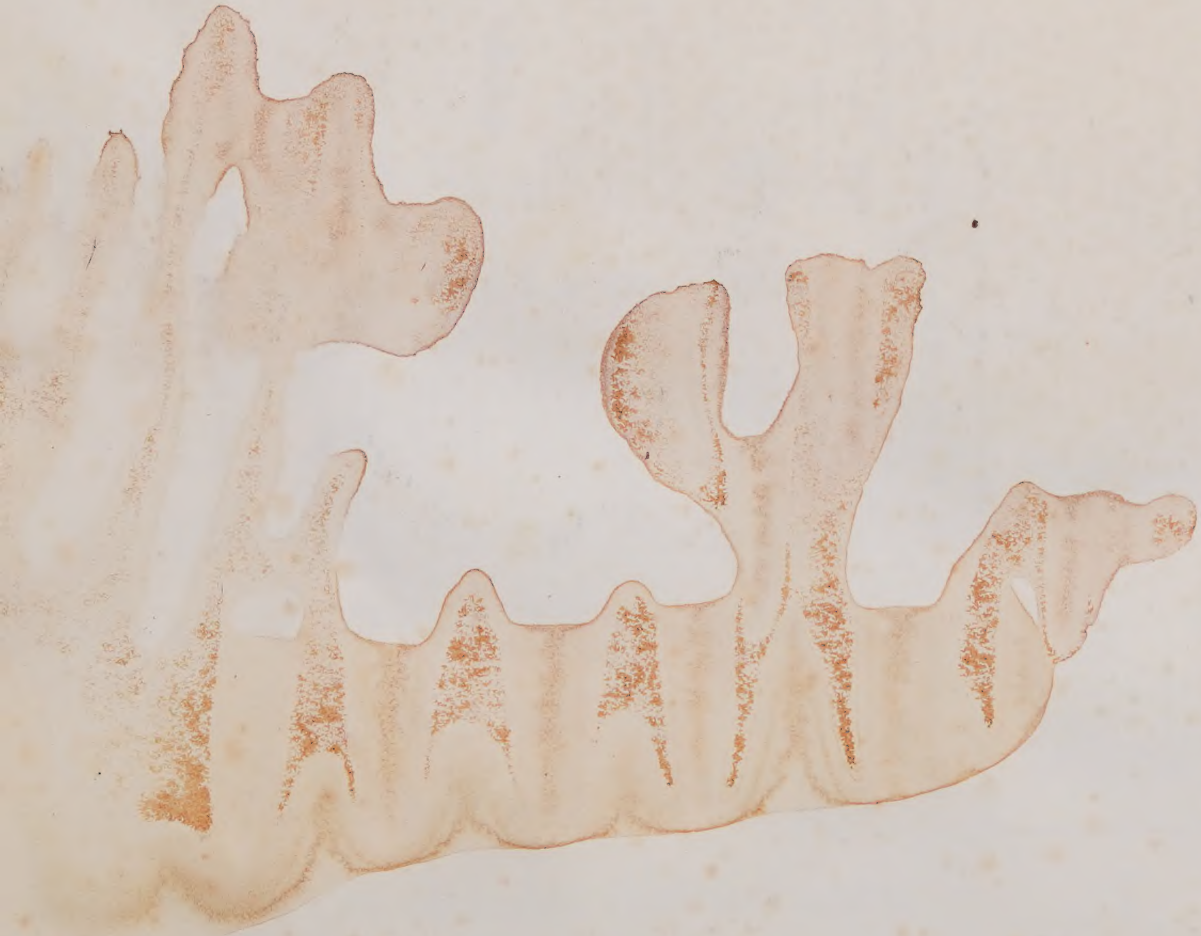

MP MASTER
MA24156